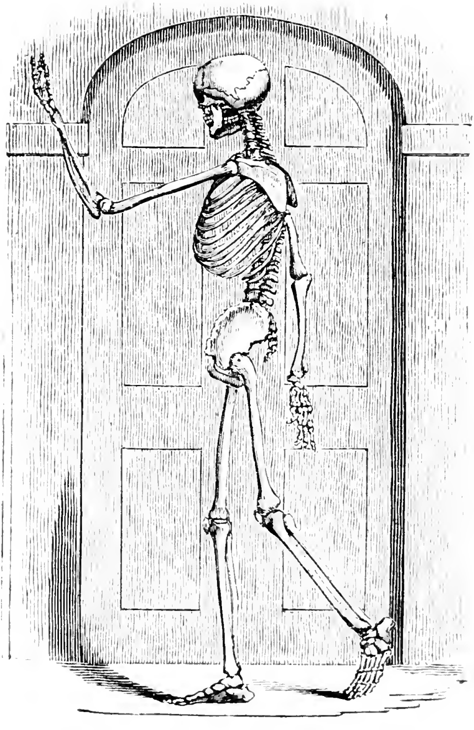
Miss Wells
1850.

For dear Rhoda
S. K. K.



'I am fearfully and wonderfully made.'

THE

HOUSE I LIVE IN:

OR,

POPULAR ILLUSTRATIONS

OF

THE STRUCTURE AND FUNCTIONS

OF THE

HUMAN BODY.

FOR THE USE OF FAMILIES AND SCHOOLS.

EDITED BY

THOMAS C. GIRTIN, SURGEON.

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EDITOR'S PREFACE.

THIS little work is founded on one published under the same title by Dr. ALCOTT, a popular American writer. In presenting it to the English public, the Editor proposes to supply a deficiency which is acknowledged to have been long felt by teachers in schools, and by instructors of youth in general.

His hope is, that, from the unpretending plainness of its style, the clearness of its descriptions, and the author's happy tact in illustration, the book will be found a valuable addition to the elementary works for the instruction of youth of both sexes.

When well grounded in its contents, the young reader will be the better enabled to comprehend and to appreciate the reasoning of PALEY, and other writers on Natural Theology, to whose works this will be found an appropriate introduction.

In preparing the present edition for the English reader, much was necessary to be done. With a large proportion of what is highly valuable, there

were, in the original work, many passages altogether inadmissible, and others, that required considerable alteration. Idiomatic forms of expression, peculiar to our transatlantic brethren, a redundancy of words, and frequent inaccuracies in the subject-matter, probably arising from errors of the press, rendered not merely a careful revision, but, for the most part, an entire reconstruction, necessary. Besides this, some entirely new articles have been added, and a fuller exposition of many of those in the original given, in order to make the work more complete, and to enhance its general interest.

It was deemed desirable to effect these changes, without abandoning, or too greatly altering the quaint and explanatory style of the author, from which the work derives much of its peculiar character; and it is confidently hoped that this object has been accomplished.

T. C. G.

Islington, Oct. 1837.

AUTHOR'S PREFACE.

The study of the human frame has usually been confined to the members of the medical profession. But wherefore? Why should not a subject which so nearly concerns us all, engage the attention of others as well as that of surgeons and physicians? Do we not carry about with us, through life, a machine so ingeniously constructed that, upon a contemplation of its wonders, an inspired writer exclaimed, "I am fearfully and wonderfully made!"

Our minds, moreover, are the tenants of bodies so constructed, as to be continually liable to waste, as well as to become disordered; and yet people in general are neither taught the way to keep them in order or to prevent them from premature decay. The condition of the body acts also upon the mind in a wonderful manner; for whenever anything in the body is wrong, either our thoughts or our feelings, or both, are, in some degree or other, affected.

To keep the mind and heart right, therefore, we should know how to keep the body right. But who understands how to do this? What persons, except medical men, as I said before, ever study the structure and functions of their bodies? Is it not strange that knowledge of such vast importance should have been so long overlooked, and practically disregarded?

There are, however, many reasons for this neglect. People naturally connect with the study of the human frame the idea of violent deaths, dead bodies, skeletons, disinterments, and dissections. No wonder the mind should revolt at so horrible a picture! No wonder that Anatomy and Physiology—for these are the hard names given to the study of the body and the laws of the body—should be neglected and shunned, if these things are inseparable from it!

But they are not so; both anatomy and physiology may be studied with advantage, so far as a general and popular knowledge of those subjects extends, without at all entering into the details of practical anatomy. Much may be learned merely with the aid of a book and a few engravings; or, in

fact, without even these. The body itself may be studied, and that is always at hand; and even if experimental dissections should be deemed necessary, portions of fowls, or of the quadrupeds killed for food may be obtained, and these would be quite sufficient for all the purposes of the non-professional inquirer. The heart, for example, of most of the common domestic animals, nearly resembles that of man, and would do equally well for any ordinary examination.

Man, as has just been observed, has a body as well as a mind. A system of education which overlooks either, is essentially defective.

It was in this view, that the author first commenced a series of essays on anatomy and physiology. The favourable reception they met with, and the solicitations of parents and teachers, together with an increasing conviction that something of the kind was really wanted, have induced him to go further, and prepare a work for families and schools.

He looks forward to the period as not very far distant, when a knowledge of the physical nature of man will be as generally taught as arithmetic and geography now; and he cannot but hope that his

labours may tend to remove a little of the repugnance which many feel to this study, by the peculiar manner in which he has here presented it.

The general plan of the work is something more than mere theory; it has been tested by experiment, in school and elsewhere, and with complete success.

There is one more hope that the author indulges, namely, that the publication of this volume will have a good tendency on morals. Still more—besides the favourable tendency which a knowledge of Physiology must have on human happiness generally—the writer believes that no branch of natural science is more likely to induce us to look "through nature up to nature's God," and to admire His "wonderful works among the children of men!"

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THE HOUSE I LIVE IN.

CHAPTER I.

GENERAL REMARKS.

"THE House I live in" is a curious building, one of the most curious in the world. Not that it is the largest, or the oldest, or the most beautiful, or the most costly; or that it has the greatest number of rooms, or that it is supplied with the most fashionable furniture. But it is nevertheless one of the most wonderful buildings in the world, on account of the skill and wisdom of the great Master Workman who planned it. You cannot view it closely in any part, without being struck with the wisdom which is there evinced; nor without feeling the mind elevated and improved by the contemplation of that goodness, which has provided everything so admirably contrived for the purposes intended to be fulfilled.

I have said that it is not the largest building in the world—very far, indeed, from that. There are very many buildings—castles and palaces—churches and cathedrals, mansions and factories—which are thousands, tens of thousands, nay, hundreds of thousands, times greater than the House I live in; indeed, it can

hardly be said, that in any country, barbarous or civilized, there is any human dwelling-place, from the hut of the savage to the regal mansion of the king, but what occupies a far greater space than the House I am about to describe to you. In truth, the latter is of very limited extent in any direction; for though it may be said to have two stories, with a cupola or dome added thereto, yet the whole seldom towers beyond the height of six feet.

It is not the oldest building in the world. The Pyramids of Egypt, erected 3000 years ago, are proud monuments of the architectural skill of the designers, and even yet seem to defy the hand of time. The sepulchral monuments lately discovered in Etruria; the splendid temples and other sacred edifices at Athens; the gigantic ruins of Palmyra, Luxor, and Carnac; the immense and elaborately-constructed caverns of Elephanta, can all boast of a very high antiquity. Many churches, castles, and palaces, though with far less pretensions to age than the grand structures I have named, may yet claim an existence of several hundred years. Many bridges, too, and other buildings, now in the course of erection, are calculated to remain for ages to come; but the building about which I am going to tell you, is never of very long duration, as compared with others, and seldom remains longer than three-quarters of a century.

The House I live in is not without beauty, but its beauty is not of that kind for which the Temple of Solomon, in the days of his glory, was celebrated. Some, indeed, are of opinion, that it is much more

beautiful, but on this point I leave you to form your own opinion, when I have told you more about it.

Nor is it the most costly. Many palaces, cathedrals, and other edifices, have required very large sums of money to erect and furnish them; on the contrary, the House I live in may be said to have scarcely cost me anything, for it was found ready to my hand. The necessary expense of keeping it in repair is but small, when the simple dictates of nature alone are fulfilled.

Nor does it contain the greatest number of rooms ever known in a building, though it may be said to contain a large number for so small a place. Perhaps it may be considered that there are fifteen or twenty. Many public buildings contain an infinitely greater number than this, and even houses of ordinary dimensions far exceed this amount.

As to the number of its occupants, it will hardly bear a comparison with any building; for, like the huts of some of the rude tribes of New Holland, it never accommodates more than one person—and that one is myself.

But even with the rude huts of the New Hollanders, the comparison will, as I have said, not hold good. They are made with the bark of a single tree, bent in the middle, and placed with its two ends on the ground. When one of the natives has taken up his abode in a hut of this kind as long as he has seen fit, he leaves it. He journeys to another place, and builds a new one, the old hut being taken possession of by any one who chooses to do so. Whereas I always carry my House with me wherever I go; in all countries, in all climates,

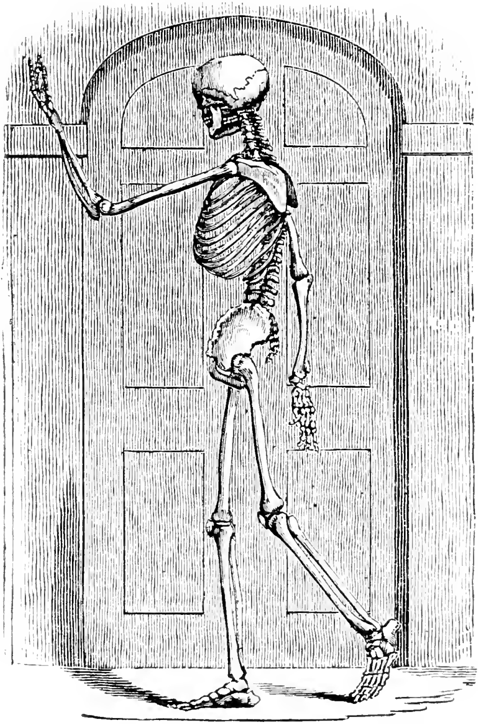
in all seasons, my House is ready for my use. The House I live in is good for nothing to any one but to myself; and when I leave it, it will immediately fall into decay.

The furniture of the House I live in is not of the most fashionable appearance. Of this the reader can judge for himself, when he understands that it has been the same in kind, in figure, and in purpose, since my House was first designed. Fashion, you know, in general, is of a varying nature; and that which in one year is held in high estimation, becomes in the next of inferior value. But the furniture of my House, being at first admirably adapted to its wants, cannot require the slightest alteration. In Siam, the houses are frequently built on posts or pillars. This is because the country is low, and apt to be overflowed every year by the inundation of the rivers, and to build on high posts is the only way to secure them against these floods. In Venice and Amsterdam, also, the buildings are erected upon piles, to elevate and protect them from the inroads of the sea. My House, as you will see hereafter, stands on pillars, but these pillars are made for motion, and to enable the building to be transported to any place that may be desired. Whereas an Amsterdam or Venetian house cannot be removed at all, and a Siamese house not without considerable injury.

The House I live in is, after all, most remarkable for its convenience; nothing could possibly so well answer my purpose. I have already told you, that it would be good for nothing to any other person. Your House,

my young reader, may be as curious, as large, and even as commodious for you as mine is for me; but it would never answer my purpose at all, even if I had it in my power, to exchange with you.

In the progress of the following chapters, I shall give you many more particulars. I shall describe to you, in the best way I can, the FRAME, the COVERING, the APARTMENTS, the FURNITURE, and the EMPLOYMENTS, of the House I live in; and shall briefly give you an account of the structure, uses, and abuses of each. At first I intended to insert a little dictionary, or vocabulary of the hard words which occur, with their meanings; but I believe it is unnecessary, for there are but few words, if any, whose meaning you will not know at once, either by their obvious sense, or by the situation in which they are placed.



FRAME-WORK OF THE HOUSE I LIVE IN.

Chapter II.

FRAME-WORK OF THE HOUSE.

A glance at the picture which you see on the opposite page, will at once unravel all the mysteries of the last chapter; the House I live in, is my body—the present habitation of my immortal spirit. I will first proceed to call your attention to the framework of my House, which consists of bones.

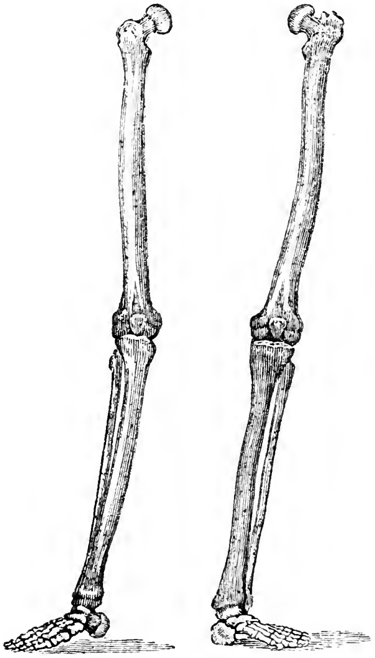
THE PILLARS.

The pillars are the bones of the lower extremity. Standing by themselves, as they do in the next engraving, and detached from all their connexions, you may be apt to think that they are not well proportioned; but, as you see them on the opposite page, conjoined with the rest of the building, they will appear very differently.

I spoke of the lower extremities of the human frame. These are commonly reckoned in three divisions—the thigh, the leg, and the foot. Besides these, there is the knee-pan, or *patella*. Each thigh has one bone, each leg two, and each foot twenty-six.

Besides these—fifty-eight in the whole in both legs—and the two patellas, or *patellæ*, there are in some people, at the largest joint of the great toe, one or two

small bones, having a slight resemblance to the knee-pan, or patella. They are called *sesamoid* bones, be-



cause they have been supposed to resemble the seeds of the *sesamum*, a wild Eastern plant.

THE THIGH-BONE.

The bone of the thigh is called the *femur*. It is the longest bone in the whole human frame. At its upper end, where it is connected with the hip-bone, is a round knob or head. This head fits into a corresponding hollow, or cavity, of that bone, and is fastened there in a way which will be described in another place. The cut just referred to represents this important part of the human frame very correctly.

THE LEG.

The lower end of the femur joins with, or rather rests upon, the large bone of the leg. The leg below the knee consists of *two* bones. The *tibia* (so called because it resembles a tube, or pipe, or, as some have imagined, a hautboy) is much the largest. The other is called the *fibula*. They are so placed that the fibula is on the outside. Where the tibia and the femur meet, they form what is called a *hinge-joint*, which means a joint that will only allow of motion backwards and forwards in one direction, like a door on its hinges. But more about this in another place.

THE KNEE-PAN.

On the fore-part of this lower extremity, where the femur meets the tibia and fibula, to form the knee-joint, the patella or knee-pan is placed. This is a round flat bone, not joined to the other bones, but lying very closely upon them, and kept in its place by what

are called *tendons.* You may see a little how this bone looks in the last engraving; but I here present you with a picture of it on a larger scale.

Although this bone might seem at first view almost useless, yet it serves many important purposes; and there is scarcely a bone in the body but might be spared as well, if not better than this.

THE FOOT.

The bones of the foot have a general resemblance to the bones of the hand, which I shall describe fully in another place. But they differ from those of the hand in several important particulars.

The foot is composed of twenty-six little bones, strongly fastened together by gristles and ligaments. These ligaments yield, when we bear upon the foot, just enough to enable it to conform to the surfaces on which we tread. If the foot consisted of one solid bone, it would not yield or spring at all; and it would be liable to be broken when we jump or fall on our feet. Think how clumsy a wooden foot would be; and one of solid bone would be nearly the same thing.

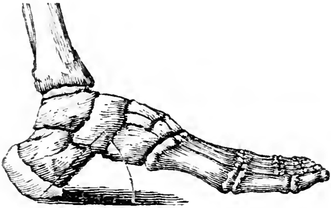
ARCH OF THE FOOT.

The *arching* of the foot is a singular contrivance. It is very much like the arch of a bridge, upon its two abutments. I will explain.

In the following engraving, the foot is not placed flat down upon the ground, but in the position it takes when we walk, and are just setting it down. Then, as

may be seen by the two lines drawn, it descends in a semicircle from the point of the heel. The lowest extremity of the heel, and the ball of the great toe, may be considered as the abutments of the arch, while the bones of the instep form the arch itself.

You may easily perceive, by lashing a strip of wood to the bottom of the foot, how awkwardly we should feel if we were obliged to walk with a *flat* foot. It is quite evident there would be no *spring* when we tread on it; we could hardly walk, run, leap, or swim at all.



The heel is not exactly under the leg, but runs back something like a spur, and is fastened to the main body of the foot by a very firm but springy (elastic) joint. On this account, when we walk, (the heel being thus projecting, and having a great deal of elasticity,) we put it down first, and the whole weight of the body does not come down with a jolt, which it would otherwise do, but more gently.

Taken altogether, the foot is a most admirable contrivance. It is, indeed, arched *both* ways; from the toes to the heel, and from side to side. Little, if any,

of the middle part of the foot touches the ground at all. There is, however, a trifling difference in the form of feet; some persons have them much flatter than others; though all people have the soles of their feet considerably less arched than is shown in the plate, on account of the muscles, tendons, blood-vessels, &c., which in a great degree fill up the hollow.

I have said that the human foot is a most admirable contrivance; and it is so. There is nothing like it to be found among the other animals, though we find wonders there also. When we examine the foot of the camel, the elephant, the horse, the dog, the cat, or the bird, we are struck with the wisdom of the Creator, in adapting their feet in so remarkable a manner to the sort of life they are destined to lead. The foot of the camel is so formed, that it does not sink deeply into the sand on which it travels. The horse, indeed, could not travel much in the deep sands of Arabia, his foot being more elastic, and adapted for firmer ground; it is, indeed, so very elastic, that those who *shoe* the horse find it necessary to make the shoe as narrow round the edge as possible, so that the iron may not press upon the softer and more elastic part of the foot inside the hoof.

THE ANKLE.

Between the lower ends of the tibia and fibula, and the bones of the foot, are seven short bones, not unlike those of the wrist in shape, but rather larger. Of these you will get a tolerable idea, when I come to describe the bones of the upper extremities.

Chapter III.

MATERIAL OF THE FRAME.

You have already seen that the frame-work of the House I live in consists chiefly of bone. I think, therefore, before we go any farther, I ought to tell you how bones are constructed, and of what substances they are formed.

STRUCTURE OF BONE.

Timber is evidently full of little holes. If you take a piece of wood, of several sorts that might be mentioned, and placing your mouth at one extremity, blow hard, you can force a portion of air through it from end to end. This shows that there are little holes, or tubes, running through the entire piece. If you could blow hard enough, you might force air through any kind of wood. The experimental philosopher, by the assistance of adequate machinery, will force water and quicksilver through the pores of almost every sort of wood.

But you cannot blow through any of the pieces forming the frame-work of the House I live in. This shows that the internal structure of bone, though in appearance similar, is yet very different from that of wood. I will endeavour to show you wherein it is different.

SHAPE OF BONES.

Bones are of three kinds: *long* bones; *broad* or *flat* bones; and *round* bones. The long bones have a cylindrical channel nearly throughout their entire length, which contains marrow, or pith; but the other two sorts of bones have no such cavity within them. They have, however, a great many little holes or cells in the inside. Some of them look, upon being broken, almost like sponge or honeycomb. Some of the long bones, besides being hollow, are also spongy. They are generally much larger at each extremity, and the spongy, or cell-like appearance, is there much more apparent. Towards, and at, the middle part, they are smaller, firmer, and contain fewer of these little cells.

All the bones in the body are very hard on the outside. Perhaps the teeth are the most so. The inside of the teeth is not much harder than other bones; but the outside is coated with a substance called *enamel*, which is very hard indeed.

PARTICULAR DESCRIPTION OF THE BONES.

You have already been told that the long, round bones, such as the *humerus*, or bone of the arm, and the *femur*, or bone of the thigh, are hollow, and contain marrow in their cavities. This marrow nearly, or altogether, fills up the hollow spaces.* These hollow spaces are lined by an extremely thin and delicate membrane,

* This is true of the bones of most other animals besides man. The bones of many birds, however, are entirely hollow, and contain air, to assist them in flight.

which also runs in among the marrow. The same sort of fine membrane also lines the cells contained in the spongy bones. These cells have a small quantity of liquid in them, and none of them appear to be entirely empty.

Most of the bones are pierced through their outsides, with one or more holes of considerable size, through each of which is carried an artery to convey blood to nourish the bones, and a vein comes out by the same aperture to bring back the blood when it has fulfilled its office. You may wonder that I should talk about blood in the bones. But there *is* blood in them, though not a great deal. This blood, with its vessels, the nerves, and the membraneous linings, together with the marrow, and liquid matters, amount to many pounds in weight: for after the bones of any animal have been thoroughly dried, and all moisture extracted from them, they become diminished to almost half the weight they originally were. The entire bones of the human body, when perfectly dry, weigh from eight to twelve pounds.

When they appear entirely dry, if you burn them in a hot fire for a long time, you will lessen their weight a great deal more: I believe about one-half. What is burnt out is the animal substance, principally composed of *gelatine*, or a material very similar to glue. The half which remains is principally lime, combined with an acid, forming phosphate of lime, with which some portion of carbonate of lime, or chalk, is mixed.

The great purpose which the Creator doubtless had in view, in giving us such a frame-work of strong

bones, was, that it might support, and give solidity to, the soft and fleshy parts. Suppose, now, that there were no bones; and that the whole body was a mass of flesh only. Would not the legs give way, and finally be crushed down under the great weight of the body? would not the arms fail in the duties required of them? Most certainly they would.

But there are several other important uses for bones, which might be mentioned. Some of them, however, you would not very readily understand till you know a little about muscles and tendons, which are the moving powers. I will, therefore, for the present omit them.

GROWTH OF BONE.

We are not born with the bones as hard as they become after we begin to walk and to run about. At first many of them are very soft, and a large number of them are in several pieces, with cartilage, or gristle, between them. After a few years they grow firmly together. The bones of the head, in particular, are at first separate; and, without doing any injury to the soft and delicate structure of the brain, contained within them, admit of some little motion, overlapping each other, as it were. But, after we become older, and the whole skull has acquired firmness and solidity, it would require a very considerable force to remove them from each other, and the consequences of so doing, if we were enabled to effect it, would be highly dangerous.

There is, undoubtedly, *life*, as it is often called,

(though we hardly know what life is,) in bones. While we continue in good health, and the functions of the body are duly performed, there is not much feeling in them ; though in some cases of disease they are endued with exquisite sensibility. When the surgeon amputates a limb, the proceeding of sawing through the bone is the least painful part of the operation, though people in general are apt to imagine that it is highly so.

VESSELS IN BONES.

There are also many minute blood-vessels and nerves running about in every direction through very small channels in the interior of the bones. That blood is certainly conveyed through and into bones, can be made very evident, by forcing, by means of a suitable apparatus, compositions made of liquid wax and other substances, and coloured, to represent blood.

Another method is also used to show that blood circulates through bones. If a rabbit, or other small animal, be fed upon madder-root, in a short time the bones will be found to be tinged with the colouring principle of the madder.

We are now, I think, prepared to go on with our studies on the frame-work of the House.

CHAPTER IV.

SILLS OF THE HOUSE.

MY readers, I dare say, know, that, in building a house, strong pieces of timber are laid upon the walls, where openings are to be made, for the purpose of supporting, or, as the builders call it, carrying, the weight of that which is to be above the opening. These pieces are called sills, and they not only form a base upon which the necessary uprights may be placed, but they answer the further purpose of holding together both the upper and lower parts of the building in their true positions.

SITUATION OF THE HIP-BONES.

The sills of the House I live in, are two large irregular bones, placed at the top of what I have called, for convenience' sake, the pillars. These two large bones are very firm and strong. You will find so much difficulty in understanding my explanations of their shape without it, that I will show you a picture of them.

These bones are called in books the *ossa innominata.*

Os is a Latin word for bone; and *ossa* is its plural, meaning more bones than one. *Innominatum*, of which *innominata* is plural, means *without a name*, or nameless: and the word *innominata* makes a tolerable name, though rather long. So if a very young child, found in the streets, whom nobody knew, should be called Peter Nameless, that word *nameless* would answer all purposes.

STRUCTURE.

I have said that the ossa innominata were very firm and strong. They are so in grown persons—but in a child they are less so, and are in three pieces, each of which has a different name. They are joined together in front by a firm gristle, or cartilage. Behind, however, is a strong wedge-like bone placed between them. Between this last bone, called the *sacrum*, and each of the ossa innominata, there is also a very strong gristle; but it is not so thick or strong as the one I have just mentioned as situated in the front. The ossa innominata and sacrum together make a kind of cup, or deep bowl—open at the bottom, it is true, but still bowl-like in its shape. This bowl is called the *pelvis*.

HIP-JOINT.

The manner of fastening the thigh-bone, or femur, to the hollow of the innominatum, is very remarkable. I shall give a particular account of it, with an engraving, farther along in the book; so that a few words must answer for the present.

The hollow where the femur is fastened, is shaped like the inside of an egg-shell, with the small end

broken off, and has received the name of *acetabulum*, from its supposed resemblance to the cup with which the ancients measured vinegar. The round end of the femur is fastened into this deep cavity, by a very large and strong cord. This shoulder is often dislocated, or detached from its situation; but this hollow is so deep, and the cord so strong, that nothing but very great violence will break the cord or slip the femur out of its place.

AN ABUSE.

I have said that these two great bones are united by a very strong cartilage. This is true; but it is also true that while we are young, and even after we are older, if we have lived temperately, this cartilage, which is very thick, will stretch or yield much more than you would at first suppose possible. It is of very great importance to everybody—though much more so to some than to others, and under some peculiar circumstances of disease most highly so—to preserve the soft and yielding nature of these cartilages as long as possible. To preserve this advantage you must, while young, run about and play, though not with violence; you must labour moderately every day as you grow older; you must rise with the lark, and go to bed almost as early as the fowls; you must breathe pure air; your drink must be water, and your food must be of the plainest and purest kinds, and not in excessive quantity—and must be well chewed. Then you may hope to preserve your bones and cartilages in a good and healthy state till old age.

Chapter V.

BODY OF THE HOUSE.

HEIGHT.

Houses consist of one or more stories, according to the taste or design of the builder. Each story, as you know, forms a separate row or tier of rooms. Many houses have only one story. But the greater number of houses have at least two stories—some three. In cities, where land is very valuable, they are sometimes built five or more stories high. Four stories in many large towns are common. A house ten stories high, accommodating ten rows, or tiers, of people, one above another, is a curious sight. Houses of this description are to be met with in Edinburgh, and in Paris, and in some other continental cities. The House in which I live has only two stories, besides a cupola.

THE SPINE.

The principal post—the main pillar of the building—the spine, runs through both stories, and is of singular construction. We usually call it the *back bone*. Here is a representation of it—

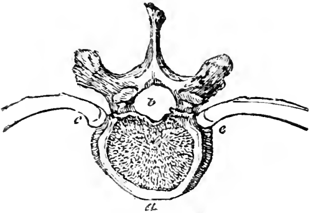
The spine is composed of no less than twenty-four separate pieces, each of which is called a *vertebra.* The plural of vertebra is *vertebræ.* The seven lower vertebræ are very large and strong. These parts of the frame are the principal supporters of the first or lower story. The twelve next above them, belonging to the second story, are somewhat smaller, and the seven which form the communication from the upper story to the cupola, or the bones of the neck, are yet smaller still. Their size in general decreases—not suddenly, but gradually — from the lowest to the highest.

The spine, or back bone, is not only curious in its shape and structure, but is of the utmost importance in the human frame. If we had no spine, the limbs, beautifully adapted as they are for their intended purposes, could not act; they would fall powerless at each attempt to move them. It has been said, that "if one member," in any part of the body, "suffer, all the members suffer with it." This is especially true with regard to the spine.

EACH VERTEBRA.

Each vertebra has a hole of considerable size through its middle (see *b* in the engraving). What is there

shown, is the upper surface of one of the vertebræ, detached from its neighbours, and standing, as it were, by itself, for greater facility of description.



When the twenty-four vertebræ are placed, one above another, in the position which they occupy in the living body, they contain a hollow channel throughout their entire length. This hollow is filled with a soft substance, very much resembling the marrow of other bones, but much more important in its offices. It seems like an arm or branch of the brain; for there is an open passage from the bottom of the *cranium*, or skull, into the hollow of the spine.

There is a very curious mechanical contrivance for admitting the head to turn from side to side, without pressing on the spinal marrow, and consequently injuring its functions. This is effected by the top vertebræ of all, and which is called the *atlas*, moving upon and around an upward projection of the second vertebra, somewhat like a tooth in shape, though of a much larger size, and situated in the front aspect of the bone, and confined in its exact situation by a transverse

ligament. By this means lateral motion is given to the head without the necessity of moving the main trunk of the spine, but simply by the aid of the first joint formed by the first and second vertebra.

GENERAL DESCRIPTION.

When the vertebræ are put together, in their proper position, there are large notches at the sides between each two bones, so exactly matched together as to form a hole. Thus there are as many holes in each side of the spine as there are vertebræ. Through these holes large branches of the marrow of the spine pass off, like the branches of a tree, to all parts of the body. These branches are called nerves. At first, they are pretty large; but they divide and subdivide, as they proceed towards the extremities of the frame, till they become very small. Their number, in all the soft parts of the body, particularly in the skin, is very great.

Those two upward projections in the plate, which look like arms, by strongly interlocking with the bones above and below them, serve as braces to the whole spine. At the sides are drawn part of the ribs (*c e*) in outline. These show where the spine and ribs come together. That projection which in the engraving extends perpendicularly upwards is called the *spinous* process of the vertebræ; this forms no part of the joint but serves for the attachment of the large muscles which move the back and head.

Between these bones, where the body of each (*a*)

rests upon the other, is a tough substance or gristle, very yielding, or elastic, almost like India rubber. This keeps the bones from wearing out too fast when they move, and yet allows of their moving pretty freely.

The spine is really one of the most curious things in nature. Rope-dancers and tumblers will bend their heads back till they almost touch their feet, and bring this straight pile of bones nearly into the shape of a bow.

The gristle, or cartilage, between the vertebræ, is very thick and strong, but at the same time very yielding; and it is so constructed and placed, as will best allow the spine to bend about in all the various ways which even tumblers and rope-dancers could wish.

It is so elastic or springy, and also so readily compressed, that people who stand or walk much, are really a little shorter at night than they are in the morning. Rest gives the elastic cartilages time and opportunity to spring back again into their places while we sleep, so that by the next morning we are as tall as ever.

I ought, however, to say—for it is a fact—that old people settle down a little, and are not so tall as in middle age; which is partly owing to these cartilages yielding and yielding till they become at length somewhat thinner.

If the soft marrow of the spine (which runs down from the brain) should happen to be bruised or injured, there would be an end of all motion, at least of the lower limbs. If the spine gets broken, it cannot be mended, and the sufferer will never entirely recover. How happy, then, that it is so admirably contrived,

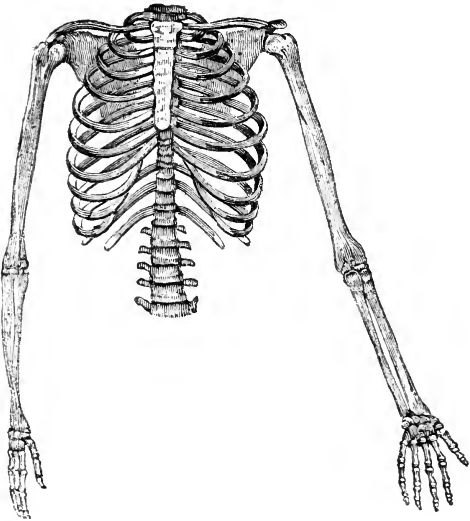
and so firmly put together, as rarely to be broken or dislocated!

The other and shorter posts of the House will be mentioned presently.

We are ready now, to study the frame of the upper or second story of the building. It consists of a much greater number and variety of parts than the frame of the first story.

THE RIBS.

The ribs may be compared to the girders of a building; though they look more like the hoops of a cask than like girders. There are twelve of them on each side. Each of them is connected, by one of its ends, to the large post, or spine; and by the other, to a short post—the breast bone. Only seven, however, are joined closely to the breast bone itself. This junction is effected by means of cartilages, to allow of greater freedom of motion in the chest, so essential to full respiration and vigorous circulation of the blood. These *cartilages* are shown in the plate by fainter lines than those which represent the bony portions of the ribs. The other five go only a part of the way across, and then unite with the cartilages of the upper seven. Those ribs which are continued round from the spine, and *join* with the breast bone, are called *true* ribs; the others, which do not form this attachment, are called *false* ribs. Here is a view of this part of the frame—



The length of the ribs increases from the first or upper one, till you come to the seventh, which is the longest. From the seventh to the twelfth they grow shorter again, and the cartilages, of course, become longer in the same proportion. The twelfth rib is very short.

The number of ribs is almost always twelve; but sometimes there are only eleven, and at others, thirteen. But instances of more or less than twelve hardly occur in one person in a thousand.

In the old by-gone days of ignorance and superstition, a notion prevailed, which is not yet wholly extinct, that the *man* has one rib less on one side than on the other. It was said that as Eve was formed of a rib taken from Adam's side, he and all his male posterity have one rib the less for it. I hardly need say that this notion is wholly unfounded.

BREAST BONE.

I have just alluded to the breast bone. The name of this, in books, is the *sternum*. It is usually considered as only *one* bone; but, like many others of the human frame, in infancy and in youth it consists of several pieces (three in number), closely united by gristle, or cartilage, but in advanced life the whole usually becomes one solid bone. Long-continued boiling, however, will separate almost any of the bones which are formed in this manner.

BRACES.

There are a few other parts of the frame of the second story which remain to be noticed, and which I shall call the braces. They are four in number—two before, and two behind. They are—

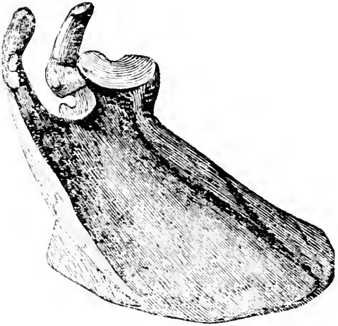
1. THE COLLAR BONE.

This forms a kind of brace between the shoulder and the breast bone, and so nearly resembles a rib, that a separate cut, to show its shape and position, seems unnecessary. You will see it in two or three of the

engravings, running across from the shoulder to the breast bone, or sternum.

2. THE SHOULDER BLADE.

This is a broad, flat bone, with ridges on it for the attachment of muscles; and, at the fore-part, is the hollow, or socket, in which the round head or ball of the *humerus,* or arm-bone, lies and moves. Here is a view of it behind.



I may as well mention that this bone is called by anatomists the *scapula.*

Chapter VI.

BODY OF THE HOUSE.—Continued.

ARMS.

These are not posts, for, in their natural position, they support nothing. They are not braces, for they strengthen no part of the frame. They are properly *appendages,* but they are very convenient ones; and though they can be removed without spoiling the building, their loss very much injures it. They seem to answer, in a great degree, the purposes of stairs, ladders, tackles, pulleys, and other machinery for raising things from the ground, and conveying them to the upper part of the building. These appendages,—we may as well at once call them the arms and hands—however, answer a much better purpose than any of these.

The arm and hand, taken together, constitute a most wonderful apparatus for motion. The particular structure of the joints, as well as the peculiarities of the hand, must be reserved for another place; but it is necessary to say a little about the arm.

The bones of the arm have a general resemblance to those of the leg. The upper part consists of only one bone. This is long and round, and is called the *humerus.* It is fastened above the *scapula:* below, at the elbow, it is connected to the two bones of the lower half of the arm, by a joint like a hinge, and by ligaments or straps, which extend from near the lower end of the

upper bone to the topmost end of the others. The largest of the two latter bones is called the *ulna,* which is a Latin word for cubit, because the arm, below the elbow, is usually considered about a cubit in length. The smaller one is called the *radius,* or spoke, from its supposed resemblance to the spoke of a wheel. It is the bone from the elbow, on a line with the thumb.

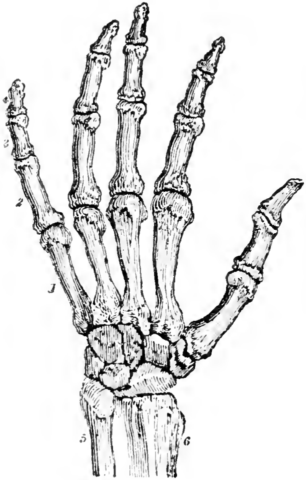
The connexion at the shoulder is such, that the arm can be moved in almost every conceivable direction. The elbow joint only admits of one sort of motion, namely, forward, and backward, like a door on its hinges. But the connexion of the *radius,* or smaller bone of the arm, with the ulna, or larger one, is such that it more than makes up this deficiency. The upper end of the *radius* having a rotatory motion in a depression of the *ulna,* allows the hand to be placed with each of its surfaces upwards with equal facility. These motions are usually designated by the terms *pronation,* when the palm of the hand is downwards, and *supination,* when the palm of the hand is upwards. Then the wrist, consisting, as it does, of eight bones, all moveable, and being so connected with the lower bones of the arm as to admit of very free motion, renders the arm one of the most useful contrivances in the world. It will perform movements as various and as rapid as the trunk of the elephant; and would probably, if it were not so common, excite as much surprise.

It was said that this whole member could be torn off without spoiling the building. Cheselden, an eminent anatomist, relates that a miller had the whole

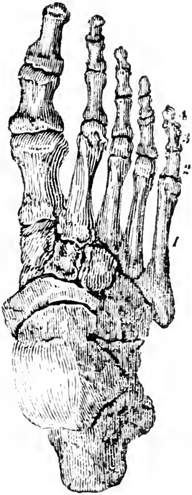
arm, shoulder-blade and all, torn off, and yet his life was not injured. The great danger, in such cases, is from bleeding; but *torn* blood-vessels do not bleed so freely as those which are *cut*.

THE HAND.

I wish to give you a few particulars about the hand. This extremity of the arm is by far the most curious part of it. Indeed, I do not know that there is a reater curiosity in the whole world than this same human hand. Yet, who thinks much about it?



THE HAND.



THE FOOT

The truth is, many of the best, as well as the most curious objects in the world, are neglected in the same manner. Think of the thousand uses of *water*. What living thing could exist without it? Yet, do we think much of all this, or are we even thankful for so valuable a gift?

The bones represented in the engraving are those of the left hand; and you look upon the top, or upper side of it. The foot is also inserted here, in the same position, but has been described in another place. *See* Chap. II.

The whole hand and wrist contain twenty-seven bones; nineteen in the former, and eight in the latter. The bones in the hand have a general resemblance, though some are much longer than others. The four longest, opposite to figure 1, support the palm of the hand, and are joined at one end to the wrist bones, and at the other to the first joint of the fingers. The junction of these bones is effected, as are all the other joints of the body, by means of cartilaginous tips, which allow of free motion, and are strongly secured by ligaments. This series is called the *metacarpal* bones.

The bones of the wrist are called the *carpal* bones. They are situated between the *ulna* (5) and the *radius* (6) at the one end, and the *metacarpal* bones and the first bone of the thumb on the other. They are wedged together, like the stones of a pavement, only not quite so firmly; each bone being tipped with cartilage, and sustained by strong ligaments, which unite it to its

fellows. All the bones which compose the wrist have had names given to them by anatomists, from their supposed resemblance to other objects; but as the enumeration of these names is quite needless in a work of this nature, they are omitted. It is only necessary to mention, that the bony structure of the wrist is of an arch-like form, with the convexity corresponding to the upper part of the hand. This configuration creates both additional strength and flexibility.

The first four bones of the fingers, opposite figure 2, are the longest. Those opposite 3 are shorter; the last, or those marked 4, are shorter still. The thumb has one bone less than the fingers. All the joints of the hand—and there are fourteen, besides the wrist—are hinge-joints, and the ends of the bones are made a little like some of our door-hinges, but they only bend in one direction. Where the fingers join to the metacarpal bones, there is much more freedom of motion than at the hinge-like finger joints, but the joint at the wrist admits of motion very freely in every direction.

When the bones of the hand are not quite so naked as they appear in the engraving, but are dressed up with muscles, tendons, membranes, nerves, arteries, and veins, and furnished with skin, and nails, in a manner which I cannot now fully describe, the whole presents a most beautiful appearance. Beautiful and useful as it is, however, and placed before our eyes from the time we see the light till we sleep in death, there are few things in the whole visible world, of

which not only young persons, but adults also, are so ignorant!

So important is the human hand, as a member of the system, that Sir Charles Bell's *Bridgewater Treatise*—a pretty large volume—is wholly devoted to a description of it. I will make a short extract from that admirable work.

"The difference in the length of the fingers serves a thousand purposes, adapting the hands and fingers, as in holding a rod, a switch, a sword, a hammer, a pen or pencil, engraving-tool, &c., in all which a secure hold and freedom of motion are admirably combined. Nothing is more remarkable than the manner in which the delicate and moving apparatus of the palm and fingers is guarded. The power with which the hand grasps, as when a sailor lays hold to raise his body to the rigging, would be too great for the texture of mere tendons, nerves, and vessels; they would be crushed, were not every part that bears the pressure defended with a cushion of fat, as elastic as that in the foot of the horse and the camel. To add to this, there is a muscle which runs across the palm of the hand, and supports the cushion on the inner edge. It is this muscle which, raising the inner edge of the palm, forms the drinking cup of Diogenes."

USES OF THE HAND.

Small as this member of the frame is, it is a part of the utmost consequence. Without it, the farmer could

not sow his grain, or plant his corn, or weed it, or hoe it while growing, or collect it when ripe; nor, if it were grown, could the miller grind it, nor the baker make it into bread. Neither could we raise anything to eat in its stead. We might get on for a few years with what is already raised; but what then? The roots and fruits which grow without cultivation—I mean without our labour—would not last very long for ourselves, and the thousands of beasts and birds which feed upon them.

Do you say that, if we could get nothing else to eat, we might then kill and eat animals? But we could not catch them. How could we?

Besides all this, the tailor could not make us clothes, nor the hatter and milliner hats and bonnets, nor the shoemaker boots and shoes. We should be obliged to go naked, summer and winter, in all climates; for we could not get even the skins of animals.

Then, again, we could not write to others for help, even if there were anybody to help us. Neither could the mariner seek a cargo of food in other countries; for he could not spread his sails, or guide the helm of his vessel. In short, we could do nothing long to any purpose; but after gazing awhile upon each other's starving and emaciated frames, we should all lie together in one common tomb—and that tomb would be the surface of the earth, arched over with the blue canopy of the heavens; for nobody could be buried.

Some may think this representation of the sad case we should be in rather exaggerated. "We should *not*

be such helpless creatures," you may perhaps say. "Why, there is a story I have seen, about a Frenchwoman, who was without hands, and yet she could do a great many sorts of work, and even *write, draw,* and *sew.*" Yes, and the story was undoubtedly true. I have heard stories like it before. I have heard of a man in the same condition, who could write with his *breast.* His pen was fastened to a girdle, and then he could dip it in the ink, and write very well with it.

But these are extraordinary cases, in which Nature is permitted, for some reason which we cannot divine, to depart from her established laws. Such occurrences, however, no more prove that people, constituted as we are, could live upon this earth without the aid of their hands, than does the existence among his fellow-creatures of a person afflicted with blindness that all could flourish without the use of their eyesight. The individuals already mentioned could not have made for themselves the pens and pencils to write and draw with, or the needles to sew with, nor could the man have placed the pen in his girdle; and there are a thousand other necessary things which they could not do.

The human tongue is spoken of by an inspired writer as being a "little member," yet boasting great things. So this small member of the frame which we are talking of is a "little" affair, but great things depend upon it. It is a sort of connecting link, that serves to bind the human soul to the habitation it occupies for a few years—rarely reaching to a hundred.

Without it, or neglecting to use it, our lives must soon terminate. "He that would not work, neither should he eat," is a divine law; and we could not work much without the aid of this beautiful piece of mechanism, the HUMAN HAND.

Chapter VII.

THE CUPOLA.

We come now to the cupola; by which term I mean the Skull, which is placed on the top of the great post before described. I have already told you that seven of the twenty-four pieces which form that post are situated above the second story of the building, and unite the skull to the trunk. You will observe the vaulted chamber at the upper part, and you may see, also, the places for doors and windows.

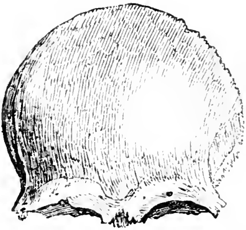
I must stop here long enough to say that—unlike what is seen in ordinary dwellings—the doors and windows of the House I live in are in the cupola: there is not one door in either the first or second story. The windows, and some of the doors, are placed in

front—the rest of the doors are at the sides. The doors and windows themselves, as you know, properly belong to the covering. They will therefore be described under that head.

I have called the mouth, and ears, and nostrils, doors, in order to keep up the metaphor which pervades the work; the eyes may, with propriety, be regarded as windows. All sound, smell, and taste, pass through the passages before mentioned, and the machinery or organs near and within them.

THE CRANIUM.

At the beginning of this chapter I showed you a picture of the whole skull. Now if the bones of the face and neck were taken quite away, and nothing left but the hollow brain-case, (*cranium*,) the appearance would be very different. Here is a view of the frontal bone, from which all the other bones have been removed.



You see, in front, the top of the cavity or socket for each of the two eyes; and on one side, the place where the ear would be in the living person. This brain-case is composed of eight bones, most of which are closely united by a rough-edge, like that of a saw, the notches of which shut into each other as the teeth of a saw would do, and form what may be called seams. These seams are by anatomists called *sutures*, and are nine or ten in number, of different lengths, according to the size of the bones which they separate. They are said to be of use in limiting the extent of fractures of the skull, and in some diseases of the brain; and doubtless, like everything else which has been formed by the beneficent hand of the Creator, they perform some important part in the great economy of nature.

One of the most important bones of the skull, or brain-pan, is that which stretches across the whole forehead, and is called the *os frontis*, or frontal bone. Another across the back of the skull, and of a somewhat triangular shape, is the *os occipitis*, the pointed extremity of which reaches to the crown of the head. Another piece, shaped a little like a clam-shell, lies around each ear; this is the *os temporis*, and there are of course two of them, one on each side. On the upper sides of the head, surrounded by those already described, are the two *parietal* bones. At the bottom of the skull, and wedging in and locking together nearly all the bones of the head and face, lies the *os sphenoides*. This is in shape something like a bat with extended wings, and has attachment to fourteen distinct bones. The *os æthmoides*, so called

from its resemblance to a sieve, being perforated with a great number of holes, for the transmission of the power of smell, lies at the root of the nose, joining the bones of the face to those of the head properly so called.

Now, as I shall hereafter show more fully, this whole space is filled up with brain. In an adult, the brain weighs from two and a half to three pounds and a quarter. In a few instances it has been found somewhat larger. It would be impossible to convey a very definite and correct idea of the bony structure of the head without a plate of each distinct bone, and its several attachments; and even with this assistance, it could hardly be effected. The bones of the skull—more especially of the lower part—are so irregular in shape, and so grotesque, it may be said, in their arrangements, as to defy description. Perhaps enough has been mentioned in this place, to give a general description of what is meant to be explained. In truth, throughout the whole body, there is not so complicated and difficult a study as the anatomy of the head; and of its great importance you will be aware, when I remind you that all the *senses* are more or less connected with the healthy performance of its functions.

Concerning the bones which compose the face and jaws, much need not be said. There are six bones on each side, which form the face, and are grouped together under the common name of the *upper* jaw. All of these bones, like those of the skull, have fanciful names assigned to them, and, like them also, they have *sutures* at their uniting parts.

The lower jaw is one strong bone, which has been compared to a horse-shoe, or a crescent; but a reference to the plate will give you a very good idea of it.

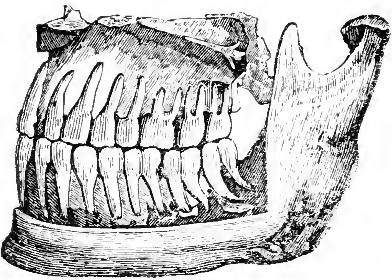
Both the upper and lower jaws serve for the attachment of very powerful muscles, which are concerned in the business of mastication, as will be explained more fully hereafter.

THE TEETH.

Around one of the doors of the cupola, and by far the largest of the whole, is a most remarkable arrangement, which requires a particular description. There is here a slight resemblance to a wheel, with its component parts, or cogs.

There are, however, no wheels, but there is something like a mill, and an operation similar to grinding is performed; the motion by which this grinding is effected, is very much like that of a pestle and mortar. One of the segments of a wheel, with its cogs, remains still during the operation, while the other moves up and down upon it, and breaks in pieces the substances which are interposed. In addition to this motion, there is a sliding from side to side which takes place, and thus the process of grinding is complete.

Look now at the engraving. This view represents the left side of part of the bones of the human face, as it would appear, if the outside of both the upper and lower jaw were taken away.



By this view, you will perceive that the upper row of teeth, and the corresponding jaw, form the wheel and its cogs which remain still; while the moving wheel, which bruises the food submitted to its operation, is the lower jaw, and the teeth contained in it, the articular surface of which moves very freely in a depression at the base of the skull, beneath the ear.

When the number of teeth is complete in an adult, and none have been lost, or drawn out, each jaw contains sixteen; and both together, of course, hold thirty-two. In the engraving, you see there are eight teeth above and eight below; that is, just half of the whole. Children have but twenty teeth at first, or ten in each jaw. These twenty are sometimes called the milk teeth, because they appear while the child's principal food is milk. These are gradually shed, between the ages of seven and fourteen years; and thirty-two new ones grow in their places.

There is a period in every child's life—say at about

the age of six years—when, if it have not yet begun to shed its first set of teeth, there are *forty-eight* in both jaws; twenty in sight, and twenty-eight beneath them, lying deep in the jaws, at the roots of the former.

When you look at the jaw-bone of a man, or any other animal, however, you do not see the roots or fangs of the teeth. They are encased or buried deep in the jaw. Those in front have only one root each; the grinders, or double teeth, have two, and sometimes more.

There are four kinds of teeth in each jaw, namely, four front teeth, two canine teeth, called also eye-teeth, four small grinders, and six large grinders. Of these, half are of course on each side.

The fore-teeth and eye-teeth have but one root each. The small grinders do not often have more than one, but they are usually indented lengthwise, so as to give the appearance of two. The large grinders of the lower jaw have two roots, and those of the upper have three—two before and one behind, or on the inside.

Who does not admire a good set of teeth? With many people they are one of the principal marks of beauty. But they are also *useful* as well as handsome, so long as they remain sound. The teeth of some persons remain sound and beautiful all their days. Would you like to have yours the same? Let us then attend to the following particular account of them; and perhaps, when we know their nature and structure more fully, we may better know how to take care of them.

The teeth are not set into the jaw-bone itself,

although they appear to be so, but into a bony appendage, which is called the *alveolar process*, which forms the true sockets of the teeth. These sockets, in old age, and when the teeth are no longer contained within them, become absorbed, and are carried away into the mass of circulating fluids by a process yet to be mentioned; hence arises that flatness of the lower jaw, and apparent shrinking of the face, which we observe in elderly persons.

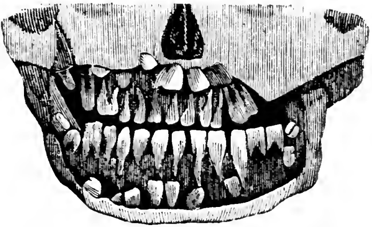
Like the rest of the bones, the teeth consist principally of earthy substance—I mean lime. But at first, children can hardly be said to have bones of any kind. Some have become to be a little solid, others have not. Where the bones afterwards are, there is at first a piece, or lump, of something which is nearly transparent, and more like jelly than bone. This in time ossifies, that is, becomes solid; and thus forms bone.

GROWTH OF THE TEETH.

The teeth, as well as the other bones, are at the first mere pieces of jelly. They do not appear at birth, for they are within the jaw-bone. And what may seem strange, the lumps of jelly-like substance which make *both* sets of teeth, (those which are shed early and also those which come afterwards in their place,) are there at the same time; one set near the edge of the jaw-bone, for early use, and the other a little deeper within it.

It will greatly assist you in understanding me, if you examine the following engraving. It shows the teeth

as they appear in a child, before it has shed many of the first set.



When the soft pieces of jelly which form the teeth become *bone*, the process is as follows:—First, a hard speck commences in the centre of a tooth, which is deposited by the blood-vessels which nourish it, and this gradually growing larger, all the jelly becomes absorbed, and its place occupied by bone.

The teeth, however, consist of something else besides solid bone. If they did not, they would very soon wear out. Do you think a piece of common bone put in the place of a tooth, would last us to chew with for half a century or more? By no means. I will therefore tell you of the

STRUCTURE OF THE TEETH.

Each tooth consists of three parts—the *crown*, the *neck*, and the *fang*. The fang or root is the part which is set firmly in a socket in the jaw-bone, as if it were driven in like a nail. The neck is close to the edge of

the jaw, where the skin or membrane which covers the jaw-bone joins to the tooth and adheres to it. (It is this membrane, as well as the gum, which the dentist separates from the tooth with his lancet, when about to extract it.) The tooth is a little smaller here, like a neck, or as if a cord had been tied tightly around, and indented it. The crown or body of the tooth is that part which we see above the gum. Every tooth has blood and feeling in it; but of this I cannot tell you the particulars now. You will find more about it in another chapter.

Now to prevent the teeth from wearing out, as a piece of common bone would do, this crown is coated all over with something much harder than any bone in the human body. It is called *enamel.*

USES OF THE TEETH.

Hard as it is, however, enamel will wear out in time. It will wear out much sooner if the teeth be picked with pins and needles, an offensive practice which some persons of coarse habits resort to. These things are too hard even for the hard enamel, and are apt to crumble it off. So is the practice of cracking nuts with the teeth, or indeed the biting of any substance harder than the crust of good dry bread. If accustomed to bite nothing harder than that is, and if not injured in any other way—for there are a thousand ways of injuring the teeth—they may perhaps last all our lives. But if the enamel once gets broken, so that the air is admitted to the softer bone under it, the tooth soon

becomes hollow, or decays. Like any other part of this wonderful frame which God has given us, the teeth will, however, last the longer for being *moderately* used.

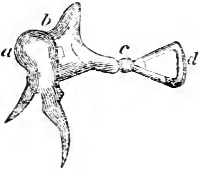
Those kinds of food and drink which injure the stomach also injure the teeth, and cause the enamel to become soft and break away. *Why* this is so, is a question which it would take too long to answer here; but you may believe the fact. In another place, I shall probably say more on this subject.

One thing more, however. The teeth must be kept perfectly clean. Never, on any account, omit to clean them night and morning, at least, with a proper brush; this is a practice no less required by delicacy than by a due regard to health and comfort, to the preservation of the teeth themselves, and as a means of escape from the racking torments of the tooth-ache.

BONES OF THE EAR.

Of all the complicated machinery which is contained in the human body, none is more apparently intricate, and more difficult to comprehend, than the structure and uses of the organ, the bony portion of which I am about to describe to you.

About three-quarters of an inch within each of the two sides of the cupola—the ears—is a film or membrane drawn tightly across the passage, like a drum-head. This is called the membrane of the *tympanum*—tympanum being the Latin word for drum; and a cavity behind the membrane is, of itself, called the tympanum.



In this latter cavity are four small bones: and they are undoubtedly concerned with the sense of hearing. Sounds reach the brain through the passage of the ear; and if there were no ear, we should hear no sound. HE who made the ear for sound, made all parts of it for some object; and we must believe that every part of it is useful.

The bone at (*a*) is called the *malleus*, because it has been supposed to resemble a mallet or hammer; but it looks as much like a crooked club, with a branch sticking out of it, as like either. It is close to the membrane of the tympanum, and touches it.

The *incus*, or anvil (*b*) is the next. It looks as much like one of the smaller double teeth as like an anvil.

A little further on is the little ring (*c*). It is very small, and seems to connect the incus to the stirrup. Anatomists, however, do not call it a ring. They call it by the hard name of *os orbiculare*. *Os* means bone, and *orbiculare* means ring-shaped.

The *stapes*, or stirrup (*d*), you cannot help knowing by its shape. It is the farthest within the head.

This little chain of bones is stretched along in the passage from the outside towards the inside of the

head, beginning at the tympanum, and ending at a small opening at a considerable distance within the head. They stand in the engraving nearly as they do in the right ear of a person, with the malleus outward, and the stapes inward towards the brain.

BONE OF THE THROAT.

It is proper to mention, in this place, that there is a curious little bone inside the neck, near the root of the tongue, called the *hyoides* or *os hyoides*. This little member has been supposed to resemble the Greek letter *υ*—upsilon—and it appears to resemble our own letter U nearly as much. You will examine for yourselves.

This bone has something to do with keeping in their proper places the parts of the body which are concerned in speaking, chewing, swallowing, &c.

Chapter VIII.

THE HINGES.

The House I live in differs in some respects, as you have already seen, from many other buildings. I will mention one more important point in which there is a striking difference.

An ordinary building of wood, brick, or stone, is intended to stand firmly, and for some time. No part, excepting, perhaps, the doors and windows, is made for motion. The ends of each part are usually fitted together by square-edged joints, with the greatest exactness. Then, to complete the whole, and make the frame as firm as possible, girths, studs, braces, &c., are added.

There are indeed a few parts of the House I occupy, which are not intended to have much motion; but in general the reverse is the case. Even the girths, braces, and studs, are designed to regulate and direct its movements, but not entirely to prevent them. The joints, instead of being framed together by means of square tenons and deep mortices, and kept as dry as possible, are rounded and made smooth, and moistened by a sort of oil, to fit them for motion, rather than to hinder it.

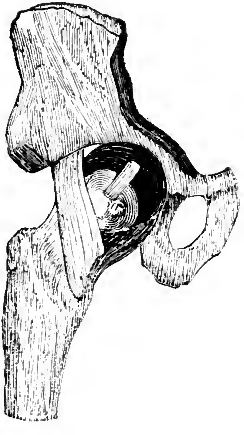
There are, indeed, a few joints—if joints they ought to be called—which are firm and unyielding. I refer to the teeth. These, as we have seen, are set into the jaw-bones, as firmly as are tenons into mortices, and even more so. They seem to stand there like nails or spikes, when driven into planks or timbers. The bones

of the head, too, are joined firmly together in adults, as you have already been told.

Some of the joints of the human frame are real hinges. To this class belong the knee-joints, the joints of the toes and fingers, and those of the elbow. The lower jaw may also be called a hinge-joint. The ankle-joints, the joints of the wrist, and indeed many others, sometimes move like hinges, but they perform other and very different motions besides.

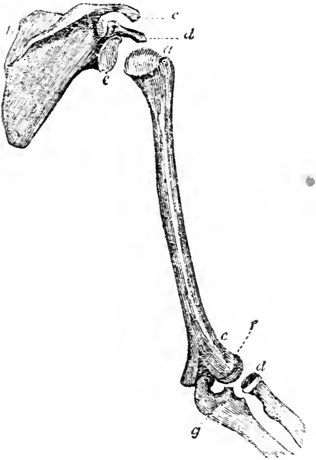
HIP JOINT.

But the most curious joints in the human frame are what are called the ball and socket joints. The more important of these are the shoulder and the hip. I will show you a plate of the one at the hip.



At *a* you see the deep hollow or socket in the bone, where the round head of the *femur*, or thigh-bone, moves. This round head is drawn back from the bottom of the socket a little way, in order to show the round ligament near *a*. The latter is a very tough, strong cord, fixed by one end at the bottom of the socket very firmly, and by the other fastened as strongly to the round head of the femur. If it were not for this ligament, the joint would be dislocated, or slipped out of its place a thousand times more frequently than at present, for indeed it now but seldom happens. I ought also to say that there is a tough, gristly rim around the socket at the hip, which greatly increases its depth. This socket is called the *acetabulum;* meaning vinegar-cup. It was supposed, as I observed before, to resemble one kind of ancient vinegar-cup in use among the Romans.

I will show you a figure of another ball and socket joint, and also of a hinge joint—the shoulder being an illustration of the ball working in a socket, and the elbow acting upon the principle of a hinge. Every one understands the nature of a hinge, which is in such constant use, and therefore the motion of the elbow-joint will be very readily understood. It has been asserted by some authors, that the first mechanic who ever formed a door-hinge, took the idea of it from the hinge-joint of some dead animal. But of this, of course, we know nothing. Now for the engraving.



I will first describe the joint of the elbow. The lower portion of the arm is formed of two bones, one large, called the *ulna*, and the other smaller, called the *radius*. The upper end of the small bone *d*, is a little rounded, and it lies against a small hollow, or depression in the other bone, the ulna, at *g*, to which it is tied by cords, called ligaments, particularly by one which goes round it like a band. The ends of these two bones, thus united, turn on the end of the upper one, which is rounded and tipped with cartilage, and thus fitted for the purpose, as you may see at *f*. They are kept together in a living person (as indeed all

bones are) by broad and short straps or cords, called ligaments, which adhere to each end of the bone a little way from the joint, and are very tight and strong, and yet not so tight as to hinder the proper degree of motion.

Let us here stop to reflect upon the great proof of intelligence and design which is here so admirably displayed.

To enjoy the entire use of the arm, two distinct motions are requisite, which may be employed separately or together, at will. For this purpose, while one of the bones of the fore-arm only, the ulna, is attached to the humerus, or bone of the upper-arm, the smaller bone of the fore-arm, or radius, is enabled to move in a hollow, or depression of the ulna, by means of its rounded upper end. A glance at the plate will readily explain this. At the lower end of the arm, this arrangement is reversed: the radius, instead of furnishing the head or rotating tubercle, becomes in turn the recipient, and the prominence of the ulna plays within a depression on its surface. By means of this reversed arrangement, the greatest freedom of motion is admitted, and, by the greater pliability which is gained, fractures and dislocations rendered less likely to occur.

But a ball and socket joint is more curious still. The bone which is represented at *b*, is the *scapula*, or shoulder-blade. The hollow place at *e*, is the socket in which the round head or ball, *a*, of the upper bone of the arm, (the humerus) plays freely when the arm is moved. The socket is so shallow, and the ligaments

so long, in order to enable us to make almost every kind of motion with our arms, that it is much more easily slipped out of joint or dislocated than are the hinge-joints. Even the hip, which is also a ball and socket joint, has a much deeper socket; and it is partly on this account, and by a different arrangement of muscles, that we can swing our legs round with as much freedom as we can our arms.

But though the shoulder-joint is rather easily dislocated, it is not so readily put into its place again, when it once gets out, as you may imagine. It sometimes requires all the skill of a surgeon, and the strength of one or two strong men.

The number of hinge and other joints in the frame of the House I live in is very great. It must be nearly, if not quite, a hundred and fifty.

You see the wisdom of the great Creator fully displayed in this structure and connexion of the bones. What if the joint of the knee could move in every direction like that of the shoulder? Do you not see that, when we walked, the legs would have dangled about strangely, instead of moving backwards and forwards in one direction only? And is it not plain that we never could have stood firmly on the ground? In like manner, how very inconvenient it would have been, to have our finger-joints move one way as well as another! On the contrary, how confined and cramped would have been the motion of the arm, if the shoulder had been like the knee, and had only permitted the arm to swing backwards and forwards, without our being able to carry it outward from the body.

The builders of machines have sometimes made joints in their machinery very much like the shoulder-joint; but it is doubtful whether they ever could have contrived such, if they had not first looked at the bones of man, or some other animal; for other animals have these various sorts of joints adapted to their peculiar wants, as well as man.

LIGAMENTS.

But how are the joints held in their places? When we take up a bone which has lain, perhaps for years, bleaching in the sun and rain, we see that the ends are smooth, and some of them hinge-like; but if we take up two such bones, and put them together, they will not stay in that condition a moment, unless they are fastened by strings or wires, or something of the kind. How, then, are they kept together in the living person? This is what I am now about to tell you.

They are held together by short and strong straps, called *ligaments*. Some of them, however, are longer, and begin at a considerable distance, say an inch or two, from the very end of one bone, and then, after passing over the joint, are fastened into the next. This strap, or ligament, does not adhere or stick to the joint, as it passes loosely over it, but is only fastened strongly, where it rises, and where it is inserted, as if it were there glued to the bone. The inside, where, in crossing, it lies against or rests gently on the joint, is very smooth; so that the joint, in moving, may not grate or wear out.

These ligaments are white and shining, but not always very thick. They are usually very strong. Some of them are as narrow as a piece of tape. Others, as at the side of the knee, or at the shoulder, are very wide. Some cross each other, as in the knee-joint. The latter are shown in the engraving *a*. There are others that go all round the joint, and completely shut it up: as if the ends of the two bones were put into the two open ends of a short cylinder, or rather of a short bag or purse, and the open ends were then gathered round, and fastened tightly to the two bones; in this way, the joint would be completely shut up, as in a sack. This sort of ligament is called a *capsular* ligament. It would be difficult, nay, even impossible, to enumerate all the ligaments in the body; they are in many instances so interwoven with each other, and frequently inseparably united. It will be sufficient here to mention that the junction of the head with the spine, the whole length of the spine itself, the hand and the foot, are literally crowded with ligaments of different shapes and attachments, as may be best adapted for imparting strength and flexibility; and that each of the larger joints has several ligaments in connexion with it, the knee-joint alone being considered by some anatomists as having fourteen distinct ligaments to its own use.

CAPSULES.

The bags, or sacks, called *capsular ligaments*, are principally intended to prevent the joint from being easily slipped out, or dislocated. They also serve for another purpose, scarcely less important—a purpose which shows the wisdom of the great Creator in the contrivance of the human frame, more than almost any other; if, indeed, any comparison can be made where all is excellent.

WEAR OF THE JOINTS.

Now, what prevents the joints of the human body from rapidly wearing out, when we walk much or run swiftly?

The Father of the universe is the preserver as well as the creator of this "wondrous frame." Was there not something done to keep these joints oiled, if I may so call it, they would not last long. Take the knee, for example, and think what a vast deal of friction or rubbing together of the end of the thigh bone and of the two leg bones there must be.

A traveller probably swings each leg, in walking, about 1200 times in a mile. If he should walk thirty miles a-day all the year, excepting Sundays, he would swing each knee 15,024,000 times.

Were he to do this every year, from the time he was twenty years old till he was seventy, or for a period of half a century, the number of movements would be 751,200,000 times!

"A continual dropping," it is said, and it means dropping of water, "will wear away a rock." And the saying, though old, is true. This continued rubbing of the bones of the knee together, if they were allowed to get dry, would wear them so much in a single day, that we should hear a grating noise at every step long before night, and in a very few days, the bones would be completely worn out, and unfit for use. I question if they would last even a whole day. Iron or steel, or even the hardest material you can think of, would wear out in a very short time. What, then, can be the reason why the knees and all the other joints do not wear out? There is no place to put in tar or oil to prevent it, as is done in various mechanical contrivances which are of human construction, and without which their due operation could not be sustained.

SYNOVIA.

I have said that many of the joints are completely shut up, as if they were in a sack. Now the Author of the frame has so contrived it, that a substance, called *synovia*, which answers all the purposes of oil of tar, continually oozes out on the inside of the ligaments, at the joints, and keeps the ligaments themselves and the joints soft and moist. Can anything be more curious? Can anything prove more clearly a great Designer, or, as I might say, a great Master Builder?

One thing may be advantageously remembered:—The synovia, or liquor which thus oozes out to lubricate the joints, will be of just the right quality and quantity

when we are in perfect health. If we are unwell, there may be too little or too much, or it may be too thick or too thin. When we use food or drink that is too heating or irritating, after awhile the synovia will become less in quantity, or of poorer quality. It is said that persons who use much spirits or opium, or continually eat improper or heating food, are very apt, in the end, to have a grating in their knees and other joints.

In all such cases, and in other evils, prevention—where we can prevent them—is better than cure. Those who live on a moderate quantity of plain food, and avoid strong drinks, and work steadily but moderately, rarely have any trouble of this sort.

It has been said that the ligaments hold the joints together. They do so; but the tendons or straps which go off from the ends of the muscles, and are fastened into the several bones around their joints, materially help to hold them together. There are other wonderful contrivances to keep the joints firm and yet moveable, but it would take too long to go fully into the subject now.

ABUSES OF THE JOINTS.

That the great Creator made the joints to be used, is proved from their curious structure, and from the substance prepared to moisten them; but that they were not made to be used too violently, is also proved by the fact, that if thus used they become diseased. Sometimes the liquor called the *synovia* dries away: in

these cases, we hear the grating sound already mentioned, and the limb becomes stiff and incapable of motion; at others, the joints become painful and often enlarged. It is but seldom, however, that they become diseased from mere walking, if we walk ever so much, provided our habits are temperate and regular; though occasionally rheumatic, and other painful affections, will encroach upon the ease of our sensations, and the symmetry of our forms.

Chapter IX.

REVIEW.

Let us here sum up, or review what we have read; it will be very useful in fixing more strongly in the mind that knowledge which we have already gained; and enable us to start with greater confidence and advantage upon the topics which will next demand our attention.

NUMBER OF BONES.

The *cranium*, or that part of the head which contains the brain, consists of eight different bones. There are fourteen bones of the face, besides thirty-two teeth. Then there are four very small bones in each ear, and one at the root of the tongue. Thus the whole head about the neck contains sixty-three. The neck has seven, but as these form the upper part of the spine, they are usually reckoned with those of the body.

Here let us stop to comment on the simple, yet effectual, contrivance for increasing the security of the brain. Had the cranium, or brain-case, been composed of one entire bone, instead of several, fractures would have followed almost every injury on its surface, and such fractures as do occasionally take place, would probably be of greater extent, and of corresponding danger.

The spine, or back-bone, contains twenty-four pieces, called vertebræ; and between these and the lower extremities are four bones more. There are twenty-

four ribs; that is, twelve on each side, and a breast-bone, or sternum, down the middle of the front. Thus, that which is commonly called the body, contains fifty-three bones.

The upper extremity, including the hand, arm, *clavicle*, or collar-bone and *scapula*, or shoulder-blade, consists of thirty-two pieces, or sixty-four on both sides. Each lower extremity includes thirty bones; and thus both together make sixty, besides the small sesamoid bones.

Now, if we add together these several numbers, we shall find that a complete human skeleton contains no less than two hundred and forty bones! Who would suppose this, from a mere view of the human figure, either while standing, or with the limbs in motion? We now see that it has a great many joints within it, and of course a great many bones. At every part of the body where the bones meet, there is more or less of motion, (excepting at the junction of the several portions forming the head, face, teeth, and hips,) and these may all be moved, nearly at the same instant. Thus there are in the human frame about a hundred and eighty joints.

We may, indeed, add to this number the small sesamoid bones, which are found in the thumbs and great toes of older persons, and somewhat resembling the knee-pan in shape, though very diminutive in size. Of these there are often two in each large joint of the great toe, and as many in the large joint of each thumb. Adding these, then, to the two hundred and forty, we shall have, for the whole number

of bones in the human frame, two hundred and forty-eight.

Some make the number about two hundred and sixty; but in this, fourteen sesamoid bones are included. It should be remembered that the number of sesamoid bones greatly varies in different individuals, though nearly all adult persons have some of them, and some individuals have them in other parts of the body besides those already mentioned. They are hardly ever larger than half a pea. In addition, it may be mentioned, that some individuals have two or more supplementary bones in the skull, called *ossa wormiana;* these, when they occur, are of an irregular shape, and seldom larger than a small Windsor bean.

Besides all these, the breast bone, the ossa innominata, and many other bones of the body, are in young persons composed of several pieces, and some of them are often not very strongly united even when they become older.

Some few individuals are occasionally met with, who have a still greater number of bones; but these may generally be considered as diseased persons. A bony or chalky substance is often formed in the flesh of those who have the gout; and some of the gristly parts of the body—I mean the cartilages and ligaments—occasionally become *ossified,* that is, converted into a substance resembling bone, as do also small portions of the great arteries, or tubes which convey the blood. In some diseases, also, the bones become soft and readily bend, owing to a deficiency of the earthy matter of which they are composed.

Occasionally persons are met with who have six fingers on each hand, or six toes on each foot, and sometimes both; but these supernumerary fingers and toes do not always have bones in them.

SKELETONS.

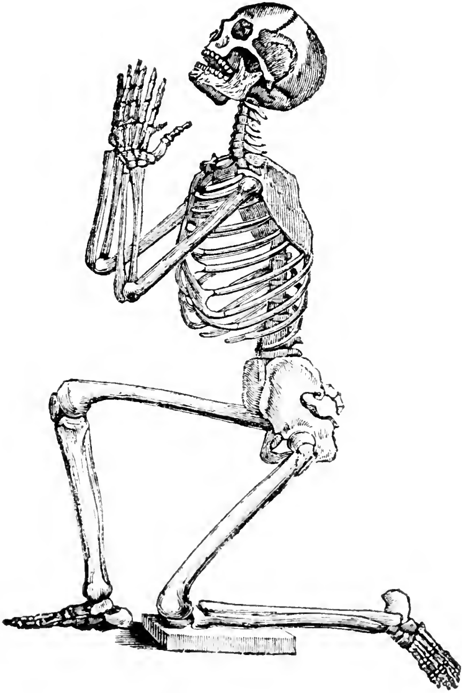
When all the bones of a human being, or of any other animal, are put together, and fastened to each other by pieces of wire, the whole is called a *skeleton.*

There is, too, another kind of skeleton, but it is not so commonly met with; nor is it so convenient for use. It is made by stripping off all the soft parts of the body, excepting the ligaments; these are suffered to remain, and the whole is thoroughly dried. This is called a *natural skeleton,* in contradistinction to the former, which is called an *artificial skeleton.*

The engraving on the next page represents the human skeleton, fastened together by wires, in the manner in which it is usually prepared. It is represented in this posture, in order to give a different view from that facing page 22.

ANATOMY.

The study of the nature and structure of the bones, and nothing but the bones, is called *osteology:* that of the muscles, and nothing else, *myology,* &c. But as most people who study these, go further, and learn also the shape and structure of the heart, the lungs, the brain, the blood-vessels, and, in fact, all parts of the body, some more general name seems necessary



for what they do. Therefore we say of those who study all parts of the human body, just as it appears the moment the soul leaves it, the bones, muscles, tendons, brain, nerves, heart, blood-vessels, lungs, skin, &c. that they are studying Anatomy.

PHYSIOLOGY.

Physiology is something more than all this. It is the study of the living animal; how the heart, the brain, the eye, the ear, the muscles, the bones, and every other part, act. David, the inspired psalmist, felt this, when, meditating on the curious structure of his own body, he exclaimed, "I am fearfully and wonderfully made." King David, however, had probably never seen a complete human skeleton, or even had much insight into the interior of the human frame; for in those days it was generally thought improper to employ the bodies of men for the purposes of anatomical research, instead of which, the remains of the brute creation, particularly dogs and other domesticated animals, were used. Hence many of the technical terms by which the various parts of our complicated structure are designated, though now appearing fanciful and erroneous, were at the time of their invention more correct, and the analogy much more obvious.

For many years past, we have been accustomed to consider it not only as allowable, but highly proper, and even necessary, to examine and dissect the human body after death, as it is by such means alone that the

true structure of the human machine can be understood and explained, and the knowledge of its various derangements acquired. That the most intimate acquaintance with the different branches of *Anatomy, Physiology,* and *Pathology,* is highly requisite for those to possess who undertake to cure or to relieve the various "ills which flesh is heir to," is admitted by all who are competent to form an opinion on the subject.

I will here take the opportunity of defining the three words above mentioned. By the word *Anatomy,* is meant a knowledge of the structure and proportions of the human, or of any other animal body; by *Physiology,* is meant a knowledge of the functions which the various parts of the body perform during health; and by *Pathology,* is understood an acquaintance with all those changes and alterations in the structure or functions which are effected by *disease.*

In writing this book, it is my intention to describe a little both of anatomy and physiology, but into pathology I shall not enter, as that will be unnecessary for the general reader. Heretofore I have treated principally of anatomy; the remaining chapters will embrace a large proportion of physiology, combining, as we proceed, the two subjects together, showing the structure of a part, and at the same time pointing out its uses, by which method, after what has before been explained, a tolerably correct idea of the subject will be acquired.

BONES AND SHELLS.

Before closing this chapter, I would observe that, although, except in very extraordinary cases indeed, the bones of deceased *human* beings are left to decay in the grave, the bony parts of the inferior animals are turned to great account in the domestic and useful arts. The handles of common knives, and innumerable little articles in every-day use, are made of bone; from which, also, some valuable products are obtained by the aid of chemistry. Ground bones make excellent manure for certain descriptions of land, and thus not only become valuable to the farmer, but furnish a beautiful illustration of the laws of nature, by which the constituent elements of the animal frame are made to contribute to the growth of vegetables, upon which human existence so greatly depends.

Ivory is another kind of bone, for it is the tooth of the elephant; as is also that useful substance, whale-bone, which is part of the structure of the enormous jaws of the whale. From the *horns* of animals, combs, lanterns, whip-handles, and many other articles, are made, while the covering of the tortoise, and the shell of a certain species of oyster, furnish us with those beautiful substances, tortoise-shell and mother-of-pearl.

The shells and bones of animals not only serve as a support to the softer parts, but also as a firm defence. What would become of the tender frame of the poor tortoise, the lobster, the crab, the oyster, and many other living things, if they were not covered over, and

protected, as with a shield, by a hard buckler of shell? The soft parts of the human body, which are most essential to life, are in many instances well defended in the same manner by the solid, unyielding materials which envelop them. As, for instance, the brain, the spinal marrow, the lungs, the heart, and the liver.

Now a portion of the shell of every animal is formed of lime. There is not so much difference between the bones of man and the shell of the tortoise or the lobster, as may be supposed, though the colour is very different. A very large proportion of the lobster-shell is lime; in the tortoise-shell the quantity is much less; and horn contains but very little. Bones, as I have before observed, contain a large proportion of this earth.

Chapter X.

COVERING OF THE HOUSE.

The covering of the House I live in differs more from other buildings—that is, possesses more peculiarities—than almost any other part of it, though every part is peculiar, admirable, and demands the highest praise. It differs from ordinary buildings, in containing no sharp corners, or square edges, for everything, even the smallest part, is more or less rounded. It seems as if the great Architect of nature had regarded roundness as a beauty, and squareness as a deformity, while, on the contrary, square sides, square edges, and angles of various degrees, appear to be regarded by the human architect as points of beauty; for not only are single buildings erected with regard to squareness of form, but whole towns and cities, where practicable, are often constructed on the same principle.

THE PERIOSTEUM.

How different the structure of the House I live in! Every bone in the frame, as if to prevent the possibility of having any rough sides or corners, is neatly covered with a very thin membranous substance; this is called the *periosteum*. *Peri* means around, and *os* means the bone or bones. There is a plain reason for this periosteum being used; our buildings, the work of men's hands, are fixed and stationary; they are not intended for motion; while the frame, and almost

every part of the human body, is made to move; and where there is motion, it is desirable that the parts should be rounded, and every possible means used to prevent friction or wearing. Besides this, the periosteum has another and very important office—that of conveying nourishment and vitality into the very interior of the bone which it surrounds, by means of innumerable little blood-vessels which ramify upon its surface.

After every bone* is covered over with this thin substance, we have the muscles with their tendons, and it is the muscles, generally, which give roundness and beauty to the human body and limbs. A large number of them are situated on the bones, especially the long bones, but a few are extended between them. The bones are generally smallest in the middle, and increase in size towards the extremities, at the joints; but the muscles are usually the reverse of this. They are largest towards the middle of the bones, and grow smaller towards their extremities.

We have a striking example of what I have just stated, in the case of the arms. The bones of the arm, as seen in the skeleton, are so large at the joints, and so small in the middle, as to make the limb appear

* Or rather every bone except the teeth, which, where they stand out of the gums, are covered with enamel. A thin membrane, like the periosteum, would do no good, as it would soon wear out in eating. The ends of the bones, also, where they rub against each other—I mean at the joints—are covered with a white and somewhat elastic substance, in which the cartilage and the periosteum disappear.

almost ugly. But when we see it dressed up with muscles and covered with the skin, it is very well proportioned. The elbow in most persons is scarcely larger than the arm is, both above and below it, and this is caused, as I have said before, by the muscles. They are larger where the bones are smaller, and grow smaller till they arrive at the joints, where they run into tendons.

But before I go further, I must tell you what Muscles and Tendons are.

THE MUSCLES.

The muscles are the flesh,—that is, the lean part of it, and are of a reddish colour, as you have probably observed. The red colour is caused by the blood; for it is not only true that blood, in small veins and arteries, runs through them in every direction, but it also tinges their whole substance. We know this is so, because, in the case of animal flesh used for food, when the muscles have been soaked and boiled long enough, the redness disappears. Even when boiled for the table, the muscular parts of animals are of a paler red than they were when they were first separated from the mass of flesh to which they belonged.

THE TENDONS.

Some of the muscles are fastened immediately to the bones, and grow, as it were, into them; and in this case, the covering of the bones, or periosteum, seems like a sort of glue, intended to cement the

muscle and bone together. In general, however, the muscles are not themselves fastened to the bone, but terminate towards each end by one or more tendons. These tendons are white, flattened substances, like belts or straps, and are very tough and unyielding. When properly prepared, they are sometimes called whit-leather; and it is almost as difficult to break this as it would be to break real leather. The muscles, then, usually terminate in tendons, and it is the latter which grow to the bone; though the muscles sometimes adhere to the bones directly at one of their ends, without the intervention of tendons.

STRUCTURE OF MUSCLES.

The substance of muscles is thready or fibrous. You have probably observed that a piece of lean meat, when boiled, has a thready, fibrous appearance, but there is one thing about muscles which does not so readily appear after boiling as it does before. A piece of meat, to be boiled, is cut off in such a manner, that it usually includes parts of several different muscles; and the whole, in this way, seems like a solid, or nearly solid mass; whereas, with a very little care, it could be parted out, each muscle by itself, though not so easily after cooking. Such is the case with a piece of beef taken from the leg of the ox; and such would be the case with a piece of flesh taken from the human leg or arm. These separate muscles are connected to each other by means of what is called *cellular substance*—a fine

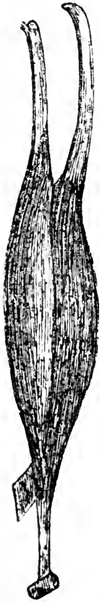
sort of membrane which I shall have occasion to describe hereafter. Each thread or fibre of every muscle is also connected to each other fibre which lies next to it by the same sort of cellular or woolly membrane.

Thus, as you see, a mass of lean flesh, similar to that which we obtain from the limbs or other parts of animals, consists of smaller bundles of flesh, connected together by the cellular membrane, but not so tightly as to hinder each bundle from moving or sliding about a little among the rest. Now each muscle, in like manner, consists of a great multitude of fibres, also connected together by cellular membrane. It is also thought by many anatomists, that each fibre is made up of a great many smaller fibres, so small as not to be visible to the naked eye.

The number of muscles in the human body is very great. Anatomists do not agree about the number, because there are many which some reckon as only one muscle, while others call them two, (for they have really a double appearance); and because a few are so small that some do not count them at all. They are usually, though not always, arranged in pairs; that is, there is one on the right side of the body exactly like one on the left side opposite to it; and so on. We cannot reckon the whole number at less than four hundred and fifty, and some make it five hundred and twenty, or even more.

I have said that many of these muscles end in tendons, or thin, whitish straps. Sometimes they terminate in two tendons. The *biceps muscle* (so

called from *bi*, two, and *caput*, a head) lies on the front part of the arm, having its upper extremity fastened to the top of the *scapula*, or shoulder-blade, by *two* separate tendons, or sinews, while the lower end



is attached to the upper part of that bone of the fore-arm called the *radius* in the usual manner, by one tendon only.

The annexed engraving will convey a tolerably correct idea of the shape of the muscles I have just been speaking of, as well as of muscles and tendons in general. You will perceive in the figure, at a short distance from the bottom, a sort of square projection, by which the artist means to represent a small portion of a *tendinous expansion*, which goes off at this part of the muscle, and, dipping down amongst, and uniting with, the muscles of the forearm, assists in binding the whole together, and preserving a unity of action.

Few muscles only have *double* tendons, and of those which have this peculiarity, few present so perfect and so beautiful an appearance as the biceps.

ACTION OF MUSCLES.

In front of St. Peter's church, at Rome, stands an obelisk of red Egyptian granite, upwards of one hundred and twenty feet in height. It was conveyed from Egypt to Rome by order of the Roman Emperor Caligula, where it remained partly buried in the earth on the spot where it had been deposited, until about two hundred and fifty years ago, when Pope Sixtus the Fifth, with the assistance of forty-one strong and elaborate pieces of machinery, and the further aid of eight hundred men, and one hundred and sixty horses, succeeded in getting it out of the ground. Four months more were required to remove it to a further distance of fifty or sixty rods, and in that situation it at present stands.

When they had at length conveyed it to the spot, the great difficulty was, how to raise it. A pedestal

was erected for it to stand upon, designed in the form of four lions; and by means of powerful machines, and many strong ropes and tackles, its lower end was at length placed upon the pedestal. They then commenced, by the aid of machinery, to raise up the column, but when it was so far elevated as to be almost ready to stand, the ropes, it is said, had stretched so much by the enormous weight of the huge mass of granite,—so much more than had been expected and provided against,—that the column could be moved no further.

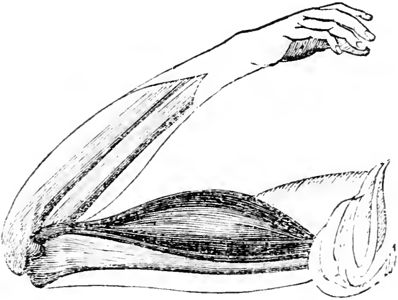
What was to be done? Fontana, the master workman, had strictly forbidden all talking; and the men stood still, holding upon the tackles so silently, that a whisper might have been audible. Suddenly an English sailor, who happened to be present, cried out, "Wet the ropes." This was no sooner said than done; when, to the surprise and satisfaction of everybody, the ropes contracted sufficiently to raise the obelisk to its place upon the pedestal, and there it has now remained for nearly two hundred and fifty years.

You probably begin to wonder what connexion this story has with anatomy and physiology. I will tell you. The muscles are those parts by means of which the head and limbs are moved, and by which locomotion is effected. In short, from the most rapid and energetic movements which we are capable of performing, to the slightest motion of the little finger, or the eyelid, all is peiformed by the aid of the muscles.

This motion, or, as it is usually termed, *muscular motion*, is effected by an alternate contraction and relaxation of one or more of the muscles, either singly or in combination. Being fastened to the bones at each end—and in the case of those muscles which move the limbs, each extremity is generally attached to a different bone—whenever they shrink, or contract, by an effort of volition, they draw one of the bones to which they are fastened towards the other. If the muscles which lie between the shoulder and the elbow shorten, or contract, either the shoulder must be pulled downwards towards the elbow, or the arm below the elbow must be drawn upwards towards the shoulder; and the same thing happens in other situations. The muscles are not capable of shrinking or contracting a great deal, it is true, but they will do so to a much greater extent in proportion to their length, than wetted ropes can.

ILLUSTRATIONS.

I must explain this matter by another engraving. Here is a picture of the right arm. It is represented as if everything had been cut away from the bone, except the single muscle of which I was just speaking (the biceps), and a portion of the skin. It is represented, too, as already contracted, and the arm drawn up as far as possible towards the shoulder; and you see how large this muscle is in the middle, when thus shortened.



In one respect, a muscle does not shrink *like* a rope; for the latter, when it shortens, or grows larger, swells all the way alike; but when a muscle contracts to draw up a limb, it swells principally in the middle. Some muscles do not swell so much as this one does when they shorten, but they are all enlarged more or less when any part of the body is moved by them.

Perhaps you do not understand how a muscle, by contracting, or shortening, pulls up the arm. I will endeavour to make it more plain.

I now sit at my table—my right arm lying upon it, which, for the sake of explanation, I will consider to be as helpless as a stick. Now, if I wish to get my hand to my head, how is it to be done? If a piece of dry rope, fastened by one end at the shoulder, and by the other to my hand, were moistened, it would shrink a little, and raise my hand from the table, but not very far.

But suppose the lower end of the rope were fastened round the middle of my arm, and then caused to shrink; would it not raise the hand higher than before—the elbow remaining where it was? It certainly would, but still it would not bring the hand up to the head, nor even half way towards it. But suppose, once more, that the lower end of the rope were fastened still nearer to the elbow; it would of course draw up the hand still more than the last.

Now the end, or *tendon*, of the principal muscle which shrinks to draw the hand up towards the head, is fastened to the arm *below* the elbow, and close to it, so that, in shrinking only an inch or so, it draws the hand up to the head. If you lay your other hand on the arm, between the shoulder and the elbow, you can feel the contraction, and at the same time see the muscles swell out.

If the lower end of the tendon of this muscle were fastened lower down, that is, farther from the elbow, it would start out so far, when the arm was raised, as to cause a very singular and awkward appearance, unless a band were put around it at the elbow, to keep it down, which would have been very inconvenient. As it now is, the tendon starts out a little way, as you may know by placing your hand upon it, or under the knee, while you are bending the limb. But the matter is so admirably contrived by the great Architect, that it renders the arm useful, gives it a good shape, and ought to raise our thoughts in gratitude to Infinite Wisdom.

But it must not be thought that there is only one

muscle concerned in bending the arm. The truth is, that in performing almost any motion of the body, a great number of muscles are employed. In moving the hand alone, we use nearly forty; and in using the whole arm, not much less, I presume, than a hundred.

I have mentioned that a muscle acts only by contraction; after a short time, this energetic state which it has acquired ceases, and the limb or joint which it has moved falls passively back into its original quiescent condition. But for many purposes of life, a rapid alternate contraction and relaxation of particular sets of muscles is required; for this purpose, most muscles are provided with antagonists, that is, every muscle which performs a *contractile* motion, has, generally, on the opposite side of the limb, an opposing muscle, which acts not only in restoring the equilibrium which had been disturbed, but, with a corresponding degree of power and energy, causes an *extending* motion. These two sets of muscles are called *flexors* and *extensors*.

To illustrate this more clearly, let us revert to the *biceps*. This powerful muscle, in conjunction with another, called the *brachialis internus*, and which lies close upon the fore part of the upper arm, by their united contraction bend the elbow. When they had spent all their force, the arm would slowly fall straight again; but to effect this straightening with vigour and swiftness, a set of muscles are provided, which lie upon the back part of the *humerus*, or bone of the upper arm, which, by their sudden contraction, extend the arm with as much force as the *biceps* and its coadjutor had bent it.

If you look upon a skeleton, you see how the bones at the joints project, and also how ragged the spine and many of the flat bones appear. Now the several hundred muscles of our frame fill up all these spaces, cover the ragged bones, and produce that round, plump, and smooth surface which a healthy human body displays.

FAT.

But I must not leave an impression that the muscles and tendons perform all "the filling up" of the human frame, for this is not the case. They are covered by the Skin, which is to be described in the next chapter. Nor, indeed, is this quite all, for there is in most persons a small quantity of fat intermixed with the muscles; and in some persons a great deal of it. The fat is found in the soft, white, cellular substance which is placed everywhere between the muscles separately, and the little bundles of which each are made up. You will now be able to understand and remember the meaning of the word *cellular*, for it means made up of cells, something like honeycomb, and the fat is deposited in those cells. A small portion only of fat is necessary to health, and when found, as is frequently the case, in unusually large quantities, in man, or in other animals, it rather indicates disease.

REFLECTIONS.

Thus we see that the great purposes which the muscles and tendons subserve are, the filling up and beautifying of the frame, and furthering the due

motion of its several parts, separately and in combination. Without the muscles and tendons so wisely blended in the construction of the human frame, we should be much more helpless than the brutes, and be the most miserable of all animals.

But with the large number of muscles which we happily possess, how multiplied are our motions. For it must be recollected, that not only the movements of the head, arms, hands, fingers, back, legs, &c., are performed by these means, but also the movements of the chest in breathing, and of the heart in the performance of its important functions. These two last vital phenomena are too often unnaturally checked by those unwise or ignorant persons who indulge in clothing too closely and tightly fitted to the form. Besides these uses, the curious processes of mastication and swallowing, of speaking, singing, crying, and laughing, are chiefly effected by the assistance of the muscles. The muscles have other uses, besides those of aiding beauty and creating motion; but the reader will not be prepared to understand them, till he knows more about the Blood and the Circulation.

Chapter XI.

COVERING OF THE HOUSE.

THE SKIN.

I HAVE already told you what cellular membrane is. Now the first layer of the covering of the house I live in, that layer placed almost internally, for there are three of them, consists of this membrane, in large quantity, and, as it were, firmly pressed together. It has a closely interwoven fibrous appearance, all the fibres crossing each other in every direction, like the felt of a hat; is strong and elastic, and capable of great distention and contraction. This material forms the principal part of the skin, or, more properly, of the *common integuments*, for it has received the name of *true skin* in contradistinction to the other two layers, which complete the formation of the covering. This true skin—*cutis vera* of anatomists—is so abundantly supplied with blood-vessels, that it seems to be composed of them in endless numbers, running along and crossing each other in almost every direction, together with nerves quite as numerous intermingled with them. Upon the surface of the cutis, the nerves become somewhat enlarged, forming little rows of eminences or pimples. These are most plainly visible on the tongue, at the edges of the lips, on the palms of the hands, and the tips of the fingers, at the extremities of the toes, and soles of the feet. Though most plentifully distributed in those situations, yet they

exist more or less over all parts of the skin, and, from their great number and extreme sensibility, are considered as forming more particularly the organs of touch. The blood-vessels and nerves are so extremely numerous in this portion of our frame, that a needle's point cannot be inserted without drawing blood, and producing pain, both which circumstances show that a wound has been given to a blood-vessel, and that a nerve has been irritated.

It is this true skin of oxen, deer, sheep, and other animals, which is employed in the arts for the production of leather. In tanning, currying, and dressing leather, the outer layers of integument are scraped off, and nothing remains but the true skin, which is then submitted to various processes to complete the preparation. But leather does not solely consist of this skin; for *tannin*, the active principle contained in the oak bark, which is employed in its preparation, combines with the raw hide, condenses it, and gives it a preservative property.

COLOURING OF THE SKIN.

We have now arrived at the consideration of the colour of the human body. As far as I have already described the skin, the colour is exactly alike in all people, whether black, red or white. Here, spread over the true skin—the part which forms the leather—on a thin, gauze-like membrane, technically termed *rete mucosum*, and underneath the outer covering of all, (yet to be described,) is a soft, pulpy, or jelly-like substance, which contains the colour. In the

African, this pulpy substance is black; in the native American, it is red or copper-coloured; in the Asiatic, it is yellow; and in the European, white: in Mulattoes, of course, it is of various shades. Here, then, you see the cause of that *variety of colour* which exists among the different families of the human race.

It is surprising to find how ignorant most persons are on the subject of colour. Some have never thought of it at all; others suppose that the whole mass of our bodies is darker or lighter throughout, according to the indication of our faces; others suppose that the colour is in the blood; and some, again, that it is in the true skin, or that part which can be formed into leather. But we see that none of these are right—that the skin itself—the *true skin*, properly so called—is alike, both in texture and hue, throughout the whole human race.

That this colouring matter effects some important purpose connected with our well-being we may be thoroughly assured, although philosophers have hitherto failed in discovering it. In the Negro, it is not only darker, but of a more dense substance, than in fairer races; and even among Europeans, it varies in thickness in different parts of the body—hence the different shades of colour in various parts of the body of the same individual.

There have been a great many conjectures about the uses of this colouring matter; but there is very little true knowledge concerning it. We know, indeed, that a dark skin, as it allows the heat of the body

to escape more rapidly than a light one, renders a person cooler, in hot weather, in sultry climates; but it is difficult to believe that this is the principal reason for its existence, as we know that natives of different countries under the same latitude, have a range of colour, from perfect black to a complexion almost as fair as Europeans.

CHANGE OF COLOUR.

There is a curious fact which deserves to be mentioned in this place. The colouring matter of some persons has been known to change. There have been several Negroes, and a few Red Indians, observed, upon whose limbs spots of a chalky white have appeared, which enlarged and spread until the whole body became white. These changes, however, are ascribed to a disease, partaking, in some degree, of the nature of leprosy.

THE CUTICLE.

I observed that the integuments of the body consisted of three distinct layers, separable by the art of the dissector. I have already described the two which lie most internally, and it remains now to describe the outer superficial coating.

This is generally known by the name of *cuticle;* sometimes it is called *epidermis,* or *scarf skin,* but *cuticle* may perhaps be considered as the best name. It is an extremely thin, semi-transparent membrane, which covers over, in every part, the other layers I have described; yet, though so closely adherent

in a state of health, by the application of boiling water, or blistering substances, it is readily separated from its connexions. This must be familiar to everybody, as scalds, burns, and the production of blisters, are of too common occurrence. Many diseases also cause the cuticle to be cast off, when its place is readily supplied by a new deposition of the same material.

Here we may stop to admire another great proof of the beneficence which the all-wise Creator has displayed in his numerous works. The facility with which the cuticle is renewed after accidents, or disease, is wonderful. The new production appears with so much rapidity, that it might be thought that it was already formed under the old one, as are the second, or permanent teeth, under the primary set, which they push out. But it is not so. The new cuticle never grows till the old one is either dead or separated from its attachments.

Were this not the case, to what pain and inconvenience should we be subjected, after even trivial injuries, and the slightest accident would prevent us from following our accustomed pursuits.

Here, again, temperance helps us much. These little injuries to the skin, though readily healed in such individuals as are correct in their habits, and simple in their diet, yet often become foul and extensive sores, lasting for years, and even ultimately producing death, in those unfortunate beings who addict themselves to gluttony and intemperance.

The colouring matter, if destroyed, is renewed, or

appears again almost as readily as the cuticle; but the real skin, if once destroyed, never grows again. This is the reason why scars are the consequence of a deep injury to the skin. The loss of the cuticle, or the rete mucosum, never causes a scar; they are reproduced exactly as they were before: but the true skin, being a much more highly organized substance, never recovers the accident. The destroyed portion is supplied by a toughish material, somewhat resembling the original structure in appearance, and which in a degree answers the purpose; but it is not real skin, nor are the proper functions performed by it.

The cuticle is not equally thick throughout its whole extent, for even in young children and infants, the palms of the hands and soles of the feet are of much greater density of structure than elsewhere, and the pressure to which those parts afterwards become subject, still further increases their substance.

You will perhaps form the best idea of what the *cuticle* is, as far as the naked eye can give it you, by examining a portion which has by accident become separated or grazed off from the body. You will then perceive how extremely fine and delicate it is—much more so than it appears to be when separated by an artificial blister, because by the latter application, it is so much soaked with the *serum*, or watery part of the blood, which has been dischar ged that it has become thickened, and does not present its natural aspect.

In its healthy condition, this scarf skin is scarcely

a fiftieth part as thick as the covering of a blister; besides which its transparency is so much greater, enabling the colouring matter which lies under it to be plainly visible.

Although by inspection with the naked eye, a tolerably correct idea of this membrane may be formed, and sufficient for all practical purposes, yet, when viewed under powerful lenses, its structure is found to partake very much of the nature of fish-scales.

HAIR AND NAILS.

As appendages to the skin may here be mentioned the Nails. These are too well known to require minute description in this place. They are supposed to be prolongations of the cuticle, or outer skin, as boiling water, or long maceration, will remove them together. They are of a closely-packed, laminated structure, and of a horny appearance, serving as protectors to the ends of the toes and fingers, and assisting in the apprehension and retention of small objects.

It will not here be out of place to speak a word upon the Hair. Hair, in greater or less quantity, is found on all parts of the body, excepting the palms of the hands and the soles of the feet, but more particularly it abounds upon the head. Hairs have their origin in little roots or bulbs, which are situated in the true skin, and are supplied with blood-vessels to afford them nourishment. There is an evident relation between the colour of the hair and the shade of the skin; dark-skinned individuals have generally dark

hair, while the hair of fair persons is usually of a corresponding colour. The hair, like other parts of the body, is liable to diseases. In this country, we are not much in the habit of observing it, but in some parts of Poland and Hungary, the peasants, who greatly neglect the necessary virtue of cleanliness, and are addicted to many bad and filthy habits, are afflicted with a grievous disorder of the roots of the hair, by which the whole becomes matted and tangled together in a most disgusting manner. This disease is called the *plica polonica.*

OIL GLANDS.

All animal frames seem to require frequent lubricating, or oiling. In some of the feathered tribes this is effected by means of the beak. They have a little gland, as it is called, which furnishes them with oil, which they press out with the bill, and apply it to the feathers, which overlap each other, that the rain and other moisture may be the more effectually warded off.

But most other animals, instead of the oil being contained in a single bag or gland, have it in numerous little receptacles, almost too small for the naked eye to detect, and deeply imbedded in the skin. In the skin of the sheep they are very thickly scattered indeed, and hence the wool of a healthy animal of this class has always an unctuous feel. They are very numerous. too, about the roots of the hair of most animals; and hence it is that the hair—even the human hair—in a state of health, appears more or less oily.

Besides these glands, which secrete the oily fluid at the roots of the hair, there are many others, situated in large numbers on various parts of the human body. They are called *sebaceous glands*, or *follicles*, and are found under the cutis, in great abundance, wherever there is considerable exposure to the air, or much friction, as in the nose, ears, groins, arm-pits, &c. There are also other glands, situated under the skin, over the entire surface of the body, which are supposed to be connected with the function of perspiration. All these glands or follicles secrete more or less an unctuous fluid, which lubricates the skin, affords it suppleness, and assists in protecting it from the weather and from the effects of friction. This lubricating fluid, healthy and necessary as it is, yet, without due regard to cleanliness of person, is apt occasionally to become a source of disease.

CLEANLINESS.

Besides these glands, which I have described, there are numerous *exhalent vessels* which pervade the surface of the whole body, giving exit to a constant vapoury fluid, which is known by the term *insensible perspiration*, to distinguish it from a more oily secretion from glands appropriated to the purpose, which is more properly termed *sweat*. This insensible perspiration is continually escaping from living bodies in a state of health, while the other secretion is formed only during violent exercise, or from a high state of temperature.

That the perspiration is constantly escaping through the skin, though insensible to the eye, may be seen by holding a bright mirror, or plate of polished metal, over any part of the surface of the body. If, unfortunately, this insensible perspiration is checked by the application of cold, damp, or other causes, for any length of time, danger, in the form of inflammation, fever, rheumatism, or consumption, may ensue. If the perspiration is also checked by neglect of cleanliness, in keeping the pores of the skin free and unclogged, much mischief may arise.

There are also other offices performed by the skin, which are very curious, but I need not mention more of them here. The more you become acquainted with the structure of the human body, and particularly of this part of it, the more you will perceive how important it is that it should be kept thoroughly clean by frequent washing, according to the heat of the climate, and other circumstances. And yet how many persons there are who pay no attention to this important duty, who seldom or never wash at all, excepting perhaps their hands and faces! Such persons are hardly fit to be trusted with a habitation so fearfully and so wonderfully wrought. In truth, by their own want of precaution, and utter neglect of so obvious a means of preservation, they are seldom as long entrusted with it as are others, who are more impressed with the importance of the charge committed to them. How true are the oft-quoted words, that "Cleanliness is a virtue!"

Chapter XII.

THE COVERING.—THE WINDOWS.

GENERAL REMARKS.

Before glass was invented, the windows of dwelling-houses were small, and made in different ways. In summer, they often consisted of a mere hole in the side of the building. In the houses of some eastern nations there were no windows of any kind in *front*, or towards their neighbours; and in China, and some other oriental countries, this is the custom to the present day.

In winter, these holes or windows were closed up with something which would partially exclude the cold, the rain, and the snow. In some countries of Asia, and in ancient Britain, oiled paper was used for this purpose. In France, besides oiled paper, they used talc, isinglass, white horn, or thinly-shaved leather. In ancient Rome, the rich sometimes used very precious stones, frequently employing agate for the windows of their baths. They had also the art of working out the horns of animals into large and thin plates, which they used in the place of glass for their windows. The Chinese used a very fine cloth, covered with a shining varnish; and, sometimes, split oyster-shells.

The first windows of common glass, which is made of sand, potash, &c., melted together and formed into plates, are said to have been made in the time of

Constantine the Great, in the fourth century after Christ; though it appears from later inquiries, that glass windows were known in Rome long before that period. But it was not till the fifteenth or sixteenth century that glass was brought into common and general use.

THE HUMAN EYE.

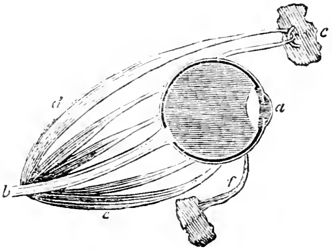
The windows of the human frame are unlike those of paper, isinglass, agate, horn, leather, cloth, oyster-shells, or common glass; nor are they situated in the back part of the house, like those of some eastern nations; nor are they very large or numerous. There are but two of them, and those of inconsiderable size, and they are set in the front of the house, in the cupola.

Both of them open and shut, rise and fall, have the curtains drawn or removed, and the blinds opened or closed, at the same time, or separately, as required. Most windows are only made to be raised, or moved, in one direction; but these move every way, and with the greatest ease and rapidity, by means of the pulleys with which they are supplied. The curtains may be drawn or removed almost with the swiftness of lightning, and hundreds of times in a minute.

SITUATION OF THE EYE.

The human eye is of a spherical form, the better to collect and concentrate the rays of light; in an adult person it is not more than an inch in diameter, and is

situated in the cavity of the orbit. It is not *fixed*, like the eyes of some animals; but can be made to roll about, upward, downward, and sideways. For this purpose, it does not adhere closely to the bone, but lies on a soft bed of fatty substance, and has many muscles or cords fastened to the sides and back part of it, as you see in the engraving.



If the eye of a dead person were cut in half down the middle, from the top to the bottom, with the handle of the knife held forward, and the point towards the back of the head, a side view of one of these halves might be supposed to look like the engraving. This view of anything is called a *section*, and this plate consequently represents a sectional view of the eye. A large whitish cord, which you see running from *b* to the back side of the eye, comes from the brain, and is called the *optic* nerve. The rest of the cords between *d* and *e* are muscles, or little bundles of flesh; and they become tendons, or hard

whitish cords, of extreme delicacy, at the smaller part, where they are fastened to the eye. The tendon of the upper muscle goes round a little piece of bone in the orbit, like a hook, as you find at *c*. The lower one, *f*, is also fastened in a very ingenious manner.

The tendon that passes round the small projection of bone is fastened to the eye-ball nearly at the top. Now it is easy to see that, if the upper muscle at *d* should contract or shrink, it would separate just as if it were a rope, and somebody pulled it;—that is to say, it would pull the top of the eye-ball forward, and cause the fore-part, at *a*, to turn downward, so that the person would look towards his feet.

The eye-ball is moved by six muscles, which are divided into *four straight* and *two oblique* muscles, and the names which they bear are given from their several uses and situations. The straight muscles are placed one on each side of the ball, one at top, and one at bottom; they have their origin from a small hole in the skull, through which the optic nerve passes from the brain, and which they envelop, and their insertions insensibly blend with the common covering of the eye.

One of the oblique muscles arises with one of the straight ones, and the other comes from the fore part of the orbits; they both unite imperceptibly with the tunics of the eye. The four straight muscles, and which can be seen in the plate, move the ball to either side, upwards or downwards, as may be wished, according to which of them is employed.

If all of them are put in motion at the same time, their united action draws the eye-ball further within the socket. The oblique muscles, acting separately, *roll* the eye to either side; when they act in conjunction, they draw the eye-ball forwards, thus having the direct contrary action of the straight muscles.

In the real eye, the tendinous expansion of the muscles is not so distinctly divided as it appears in the engraving, the fat and cellular membrane, which is very abundant, being there all removed, that the peculiar structure may be more easily perceived.

COATS OF THE EYE.

The eye is a round hollow sac, containing fluid, which is of two qualities, and is covered by several layers or coats.

The outside, or *sclerotic* coat, as it is called, can be seen in the engraving. It is very thick, and a small portion of it at the fore-part is wanting. In this vacancy or opening is set the *cornea*, a piece of membrane which is transparent, that is, can be seen through like glass. This transparent part you will find near *a*. It is placed in the sclerotica, as a crystal is set in a watch; or, if we compare the eye to a window, just as a pane of glass is set in the frame; with this difference, however, that a pane of glass is seldom round, but the cornea is as round as a sixpence. It also projects like the crystals of most watches, and through it the rays of light enter

the eye and pass to its back part. What we call the white of the eye is the sclerotica, or window-frame, as far as we can see it, surrounding the cornea.

The *tunica sclerotica*, or sclerotic coat of the eye, is lined by another and thinner coat called the *choroides*. The internal surface of the choroides is covered all over, excepting at the back part, where the optic nerve enters, with a thin sooty kind of black paste, called by anatomists the *pigmentum nigrum*, which means black pigment.

The use of this black pigment, as I shall explain more fully hereafter, is for the purpose of suffocating or absorbing the rays of light after they have performed the duties required of them.

Where the sclerotica and cornea join, a kind of circular membrane or curtain runs inwards, and is represented in the cut by two white lines approaching each other, but not quite coming together. When we look at the eye of a living person, this curtain is sometimes light blue; in other persons it is grey, hazel, or black. When this curtain—called the *iris*—is blue, the person is said to have blue eyes; when black, he is said to have black eyes, &c.

The circular hole in the middle of the iris is called the *pupil* of the eye. It is larger or smaller in proportion as the iris is more or less diminished; for the iris will shrink or contract a little, like the muscles: and indeed it is endowed with minute muscular fibres. The stronger the light is before the eye, the smaller is the pupil. When we are in the dark, it becomes very

large, in order to admit as many rays of light as possible to pass through to the optic nerve, at the back part.

The greater portion of the remainder of the eye-ball consists of a substance which I told you had some resemblance to the white of an egg, or that ropy but clear fluid in which the yolk swims. Anatomists, however, say that the greater part of it resembles melted glass, which I suppose few of you have seen: but as we have called the eye a window, the comparison is a very happy one. This fluid substance is termed the *vitreous humour:* it fills up the whole back of the eye, and preserves its globular figure. There is still another liquid contained in the eye, though in much smaller proportion than the last, and is of a more watery consistence. This, as its name implies, is the *aqueous humour.*

The edges of the *iris,* or curtain, like a partition, divide this fluid into two portions; that which lies in front of the curtain is called the anterior chamber, and the portion which lies behind the iris, and which is much the smallest, is known as the posterior chamber.

Just at the back of the iris, exactly behind the pupil, is a small body, clear, and in a degree transparent, like the vitreous humour, but much harder, and imbedded in the midst of it; without ever removing from its place. This body has a close investment, of an extremely fine nature, which binds it more closely to the contiguous parts, and is called in anatomical language its *capsule.* This body, with

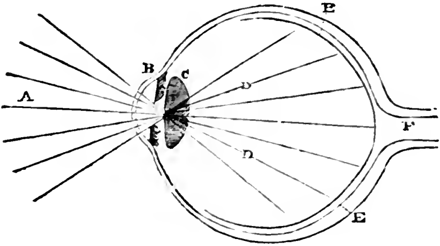
its enclosing capsule, is about as large as a middling-sized hazel-nut when divested of its shell, and in consistence is somewhat like a piece of half-melted gum. It is called the *crystalline lens.* It is rounded, or convex on both sides, and resembles two watch-glasses, with their hollow or concave sides placed together. This is represented in the engraving.

There is a disease of the eye, called *cataract*, in which the lens becomes opaque; and as the rays of light can no longer pass through it, the individual so affected becomes blind. The most effectual remedy for this complaint is by the removal of the lens from its situation, either by taking it away altogether from the eye, or else by pushing it downwards out of the sphere of vision. These methods, of course, can only be accomplished by the aid of the surgeon.

OPTIC NERVE.

The optic nerve, which I mentioned as entering at the back part of the eye, expands or spreads itself as it enters, over the whole *choroides;* and this expansion is called the *retina.* The retina, though a prolongation of the optic nerve, yet materially differs from it in appearance, the trunk of the nerve being of a cordy and toughish texture, while the retina is composed of a tender and pulpy-like substance, and is of a light grey colour. The rays of light, entering from all directions, in passing through the eye, strike first upon the cornea, then pass through the aqueous humour, and enter the crystalline lens; having arrived there,

the rays diverge, as from a centre, towards the circumference, and, traversing the vitreous humour, impinge upon all parts of the retina; and it is here—upon the retina—that the phenomenon understood by the word *sight* is effected.



A.—Rays of light from all parts. B.—Cornea, through which they pass. C.—Crystalline lens, where they suffer refraction. D.—Divergent rays. EE.—Retina, upon which the picture is formed. F.—Optic nerve.

There is a curious circumstance connected with this operation of vision, which is, that the image or picture, in front of the eye, is formed on the retina, in an *inverted* position, or as we should say, upside down. Thus, if I am looking at a horse or a tree, there is a kind of image, or shadow, of that horse, or tree, on the retina of my eye, with its lowest part upwards. Why everything seen by the eye does not appear inverted, rather than in its true position, is not known, though many very ingenious theories have been invented to account for it.

There are many individuals who have a peculiarity of vision, so that they are unable to perceive objects distinctly, without holding the thing to be viewed close to the eye. These persons are said to be *short-sighted*, and it is commonly observed in them, that they possess an eye somewhat more prominent than the generality of people. A principal cause of this defect arises from that very circumstance; the *cornea*, or that portion of the front of the eye which embraces the outer circle (the pupil, or aperture in the *iris*, being the inner and smaller one,) being too *convex* in its shape, permits the rays of light which fall through it, in every direction, to form a point, or *focus*, before they arrive at the crystalline lens to undergo that divergence which it is the object of the lens to effect. Thus, instead of all the energy of the rays which have been admitted through the pupil being concentrated upon the lens, they reach it feebly, and, as it were, dissevered from each other, and, consequently, the proper degree of divergence is interfered with.

The same defect is also supposed to be attributable to the crystalline lens itself being *too convex* at its anterior surface. I told you before, that this lens was composed of two portions; in fact, it is formed of two segments of spheres, of different sizes, united at their flat surfaces, and with such relation to each other as best suits the object to be attained. Now, if that segment which lies towards the front of the eye be the least out of proportion—be ever so little more convex than the laws which regulate vision

permit—the same evil may exist, as in the case of a too prominent cornea. It is not possible to ascertain this for certainty during life, though, according to the known laws of optics, it is highly probable; but when the shortness of sight depends upon a too great convexity of the cornea, it is readily detected upon inspection.

In order to remedy this great defect as much as possible, short-sighted persons are in the habit of holding all objects which they wish to see distinctly within a few inches of the eye; by this means, the rays of light emanating from the object to be viewed, fall upon the cornea, in a shorter line, and the *focus* is thereby formed in its proper situation at the crystalline lens. There is also a peculiar action of the *oblique* muscles of the eye-ball, which forces the inner and backward parts of the eye more forward, thus enabling them still further to shorten the axis of vision, and which may be perceived by the contractions of the muscles of the forehead, and the pursing up of the integuments under the lower lip; by which means, also, the quantity of light admitted into the eye is regulated.

Now that we have spoken of short-sighted persons, a good opportunity is afforded us of inquiring into the cause of *long sight*, which is the very opposite of the former, and is more commonly met with in individuals in the decline of life. Here is the reverse of the case we have just had under consideration; the *cornea* has become *too flat*, partly from a diminution of the aqueous humour, by which its proper distention

is not maintained, and partly from the natural shrinking of parts to which age is subject. In like manner, as the *focus* of the rays of light admitted into the pupil was formed *too soon* in those individuals affected with short sight—in the case we are now inquiring into, the *focus* is formed *too late.* The rays of light, striking through the cornea and aqueous humour, fall upon the lens, from whence to diverge towards the *retina,* before the focus can be formed; hence arise indistinctness and confusion of sight, unless the object to be viewed is held at sufficient distance from the eye to lengthen the axis of vision, and throw the focus to the proper situation.

The skill of the optician greatly enables persons afflicted with either of these defects in their sight to alleviate their wants. By means of *convex* glasses, to aid the vision of those who are *near-sighted,* and by *concave* glasses, to assist those who have *long sight,* regulating according to circumstances the admission of the rays of light, and forming the focus at the points best adapted to the purposes for which the eye was constructed, he can form very efficient substitutes for the original structures. Truly it is said, that he who invented spectacles was one of the great benefactors of mankind.

There are many curious phenomena connected with the subject of vision, which would be highly interesting for you to know, but it would not be easy to explain the peculiarities so as to convey a correct notion of them, without the aid of diagrams.

It may be sufficient here to observe, that the eye,

perhaps, of all parts of the human frame, is the most wonderful. When we consider that a few pieces of membranous material, with the assistance of a gummy substance, and a little water, form an organ which effects that astonishing phenomenon called sight, we may well elevate our thoughts to the contemplation of that great Being, to whose ever-provident care we are indebted for so great a blessing.

THE TEARS.

From a small gland, over the outer top corner of each eye, and contained just within the orbit, flows in small quantity a clear liquid, and, by means of the eye-lids, operates as a moist cloth would do over the windows of an ordinary house. This liquid is carried over the whole surface of the eye, and keeps it constantly moist and clear, the superfluous fluid being carried off through a very narrow passage, which descends from the inner corner, and is conveyed by a pipe or duct into the nose.

The little gland over the eye is called the *lachrymal gland;* the liquor which it furnishes to wash the eye is well known as the *tears*, and the tube through which the tears escape into the nose is called the *lachrymal duct.*

If this duct becomes permanently obstructed, which occasionally happens, the tears overflow the eye, and run down on the outside of the cheek, causing much inconvenience. To remedy this evil, the surgeon is often obliged to adjust an artificial tube, to convey the fluid to its proper outlet.

THE EYELIDS.

The eyelids are appointed to guard the tender organ beneath them from injury in various ways. One of their uses is to regulate the strong light of the sun when too powerful. If the eyelids were cut off, we should most probably soon become blind. Those people who are in the habit of allowing the full blaze of a lamp, or a bright fire, to shine for a long time in their eyes, run a great risk of doing injury to their sight; though sometimes many years elapse before much mischief ensues, yet ultimately disease, or defective vision, is almost sure to be the consequence.

Besides veiling the eyes during sleep, another use of the eyelids is to ward off small bodies, such as dust, chips, or stones. The power of the eye itself in this respect is extraordinary. It will sometimes close with such swiftness as to exclude an object, which it is barely possible could have been seen, almost as if it felt the approach before it arrived. It does not, however, always close quickly enough; for blacksmiths, stone-cutters, cutlers, and many other artificers, have their eyes more or less injured, from the continual ingress of small particles of stone or iron, which irritate their tender coverings.

THE EYEBROWS.

The eyebrows serve as a sort of defence to the eyes, by attracting part of the dust which would otherwise fall into them. They are supposed to

assist in shielding the eyes from receiving too strong a glare of light; they are also ornamental, and assist in giving expression to the emotions of the mind. The eyelashes co-operate with the brows and lids to prevent the intrusion of extraneous substances, and also materially contribute to the beauty of the countenance. Something might be said concerning some other parts connected with this wonderful organ, but the limits of a work like this forbid.

REFLECTIONS.

I cannot close this chapter without drawing your attention to the extreme care which has been taken to guard this delicate and valuable structure from injury. Observe its situation—placed in a deep bony socket, and immediately reposing on a thick cushion of fat, thus uniting strength with softness. How admirably adapted, too, in a situation for the purposes it is intended to fulfil; placed in front of the head, it commands an extensive range over the whole face of created things; it equally surveys the boundless profusion of the earth, and the spacious magnificence of the heavens; and, comprehending all things, it, as has been elegantly expressed, "Looks up through nature unto nature's God."

The eyes of animals, also, bear the same marks of adaptation to the mode of life to which each is appointed as do those of man himself. The organs of vision in *carnivorous* animals are placed almost in the front of the head, the better to enable them to pour the

full powers of sight upon the object of which they are in pursuit; while the peaceful animals of the *herbivorous* class, as the sheep, the hare, &c., have their eyes suited laterally, for the purpose of guarding against the danger of surprise, and of more readily avoiding their ruthless enemies.

The eyes of serpents, and most reptiles, are placed upon the upper surface of the head; any other situation would have been inconvenient: everything they require to see is above them, and to look downwards would be an unnecessary privilege, not in accordance with the accustomed operations of nature, which does nothing in vain.

The internal arrangements, too, of the eye of various animated beings, is well worthy of investigation. Observe the facility with which the iris of the cat tribe nicely adjusts itself to the greater or less quantity of light which is before it. The badger, the fox, and most night-watching animals, have the paint at the back of the eye, which is usually black, of a blue, or other bright colour, the better to reflect all the light which it receives upon the retina. In the eyes of those birds which inhabit groves and woody localities, a great flatness of the anterior part is discernible, to prevent any injury to these organs whilst flying through the thick and tangled bushes.

The crystalline lens of fishes is found to be of a more globular shape, and of a more dense structure, than it is in land animals; this peculiarity enabling all the rays of light which come from the water to be more completely refracted.

Many other points of difference in the organs of vision, in the various kinds of animals, adapted to their several uses, might be described, by which a highly valuable lesson would be conveyed; but enough has been mentioned to show the fostering care which a kind Deity has taken of the wants of even the meanest of His creatures.

Chapter XIII.

THE COVERING.—THE DOORS.

The doors of the House I live in are the mouth, ears, nose, &c. These I call doors, for reasons which have already been given, and for others which will presently be seen.

THE EAR.

Some account of this has been given in treating of the bones. The reader has already been told that it is constructed for the admission of sound; that if there were no ear, we could hear no sounds; and that a part of this curious organ lies deep in the bones of the head.

There are, in fact, two great divisions of the human ear—the external and the internal. The external ear is that part which we see in the living individual; consisting of a somewhat semicircular portion, spreading outwardly, the shape of which everybody knows; and a passage in the middle leading into the head.

The external ear—that part which is visible—is made of gristle or cartilage, covered with skin, and is concave, for the better collection of sounds. Such is the curious structure of the eye, that the rays of light from all directions are collected to the seat of vision at its posterior part; and, in a similar manner, the

structure of the external ear is so arranged, that sound is collected by it towards the passage in the centre.

This passage is lined by a membrane of the same texture as the skin, excepting that it is a little thinner; the minute oil glands are more numerous, and the secretion which they furnish is very bitter. What is called ear-wax, is the fluid in an inspissated state, and which sometimes accumulates in so large a quantity as to cause deafness, by mechanically obstructing the admission of the sound into the internal chamber of the ear. This wax, by its bitter quality, is supposed to be useful in preventing the intrusion of insects, they having a great dislike to all bitter substances. There is, however, less danger from insects getting into the ear than is commonly supposed, as they are unable to penetrate far into the head, being intercepted by the drum of the ear, which extends completely across the passage; yet, by the irritation which they would produce, considerable inconvenience might be occasioned.

The external ear, as I mentioned, is formed of cartilage, and is moved by several muscles. You may perhaps wonder what I mean by speaking of the motions of the ear, when we so generally see this organ in a quiescent state. But in truth, in the uncivilized state of man, the ears possess considerable powers of motion, and the individuals of most savage nations are enabled visibly to elevate and alter the situation of their ears, when rendered necessary by the approach of an enemy, or by other circum-

stances. The loss of this power, in addition to the deprivation of some other faculties, is amongst the penalties which we pay for our social condition.

The passage from the outer part of the ear is of a somewhat oval form, with a slight curve, and at about the distance of an inch, or an inch and a half, the *membrana tympani*, or drum of the ear, is situated. This is of a texture partly muscular and partly membranous—is firm, though very thin, and nearly transparent; its shape partakes of the nature of the passage, across which it completely extends.

Beyond the membrana tympani, or drum, is a chamber, called by anatomists the *cavity* of the tympanum; it is about half an inch in width, and has several protuberances on its bony floor, which are more or less concerned in the functions of the part. From it, several passages extend, which communicate with the adjacent parts, one of the most important of which is known by the name of the *Eustachian tube*, so called in compliment to its first discoverer, Eustachius; and many other parts of the human frame have taken their names from those of the investigators who first described them in their works. This pipe or tube is about an inch and a half in length, and runs from the upper part of the cavity of the tympanum obliquely forwards to the posterior opening of the nose, which is just above the arch of the palate. It is partly bony, partly cartilaginous, and partly membranous, in its structure, narrow towards the ear, and of considerable width towards the nose, even so much as to admit the inser-

tion of a quill.* Among the little projections which rise from the bony floor of the tympanum, there is one rather more elevated than the rest, dignified by the title of the promontory, and just above which is an orifice of an oval shape, called the *fenestra ovalis*, or oval window, which is closed by a membrane similar to, but smaller than, the membrana tympani. If you place your finger behind the outer loose cartilage of the ear, you will feel a large protuberance in the bone. This is full of cells of a honeycomb appearance, which communicate with each other, and with the cavity of the tympanum; they are called the *mastoid cells*, and they assist the sense of hearing by their vibrations.

In addition to these, there are other little apertures; but those which I have mentioned are the most important.

Besides the air which is always contained in this chamber, there are four small bones, which I mentioned in a former part of the work—the *malleus*, or hammer; the *incus*, or anvil; the *stapes*, or stirrup; and the *os orbiculare*, which is of a very minute and globular shape. It would be out of place here to

* This tube seems for the purpose of admitting air into the tympanum, to equalize the pressure of the drum, and to allow of free vibration. Were there no passage of this kind, and consequently no air within the ear, the drum would inevitably be ruptured, from the great pressure of the atmosphere on its outer side; even when the quantity is merely diminished, or not properly renewed, in consequence of an enlargement and obstruction of its capacity, arising from quinsy and other disorders, a degree of deafness is frequently the result.

describe the peculiarities of these little bones minutely, a general and correct idea is all that can be expected; indeed, were the subject too fully entertained, it would tend to confuse, rather than enlighten, the intricacy of the parts is so great, and the structure so delicate.

The *malleus*, then, has a round head, a long handle, and two projecting spikes branching out from near the neck; the handle lies lengthways across the membrana tympani, and closely adherent to it, having its head received into a depression of the *incus*. The incus, being in shape somewhat like a molar tooth, with diverging fangs, has one of them fixed to the edge of the opening into the mastoid cells, while the other, remaining free, receives the attachment of the *os orbiculare*, which, again uniting with the head of the *stapes*, forms the chain of bones contained in the cavity of the internal ear.

All these bones, small as they are—and the smallest of them is much less than a grain of mustard seed—have a separate covering of periosteum, and are united to each other, like the rest of the joints, by capsular ligaments. These bones, also, have extremely small and delicate muscles connected with them, which, pulling in various directions, as may be required, relax or tighten the drum. If the sound to be heard is faint, then muscles for that purpose, pulling the chain of bones in one direction, stretch the membrane; and if the noise be too powerful, another muscle is ready to relax it.

The next part of the internal ear for description

is the *labyrinth,* and truly so it is named, for here the intricacies multiply almost to confusion. It is situated still more inwardly than the structure we have been trying to understand, and is formed of several parts, each of which, as usual, have separate names peculiar to them. There is the *vestibule,* or porch; the *cochlea,* or shell; and the *semicircular canals.* The *vestibule* is a small cavity, about the size of a grain of pearl barley, having several openings, one of which receives the base of the *stapes;* thus forming a communication *outwardly* with the cavity of the tympanum, while others, opening into the *cochlea* and semicircular canals, continue the connexion to the most *internal* parts. The *cochlea* bears a resemblance to the spiral turns in some species of shells, or like a cork-screw staircase; it performing two turns and a half around a central pillar, and, though chiselled out of the solid bone, is yet so delicate, that the paper on which this book is printed is much firmer. The various portions of the cochlea receive many different names, to enumerate which would be unnecessary; suffice it to mention, that the whole of the dissection is so difficult, owing to the extraordinary delicacy of this part of the apparatus of hearing, and the intense hardness of the bone which surrounds and closely invests the whole, that many preparations are spoiled before a perfect specimen can be displayed.

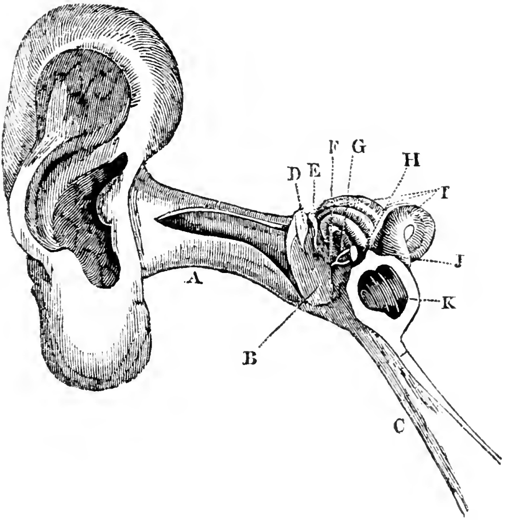
Next in order come the *semicircular canals.* These are three in number, and are named according to their situation. They form three-fourths of a circle in extent, and are of size sufficient to admit the head of a small

pin, all of which open into the vestibule. The different intricacies of the cochlea, as well as the semicircular canals, are all lined with periosteum, the same as the largest bones in the body, upon which is carefully distributed a soft, pulpy substance, upon which bed lies, guarded by the tenderest care, the *auditory nerve.* This nerve is received into the internal ear by a small aperture, and is divided into several portions, which disperse themselves over the canals, the cochlea, and the vestibule.

The auditory nerve bears the same relation to the organ of hearing that the optic nerve does to the eye. Both may be considered as the principal part of the apparatus, to which all the others are subservient.

Besides these contents of the labyrinth, a small quantity of fluid is found, sufficient to keep all the parts of this involved structure constantly filled, and which fluid is of the same nature as the aqueous humour of the eye.

If you read this description over very carefully, you will, I think, be prepared to understand the mechanism of *hearing,* for which purpose observe the engraving. First, then, the sound is collected and concentrated by the *concha,* or outer ear, and is transmitted by the *meatus auditorius externus,* A, to the drum, which is marked B; striking upon the drum, it is conveyed along the chain of bones, D E F G, to the *fenestra ovalis,* upon the membrane closing which, H, the stapes is adherent. In accordance with the degree of impulse conveyed by the bones, is this little membrane shook, which, by its motion, agitates the liquid contained



within the labyrinth, and thus acts upon the auditory nerve, which is distributed throughout the whole extent of the *semicircular canals*, I, the *vestibule*, J, and the *cochlea*, K. This agitation of the fluid, greater or less, according to the degree of sound admitted, which is partly regulated by the muscles within the tympanum, excites the peculiar action of the nerve, and the sense of hearing is the result. C indicates the *Eustachian* tube, which, admitting air to the internal ear, counterbalances the pressure from without.

How much do we perceive, in all this wonderful contrivance, to evince the consummate wisdom, as well as the beneficent intentions of the Almighty! How complicated a structure, and yet how admirably adapted to its end! How carefully guarded, too, is this tender organ—deeply imbedded in the substance of the hardest bone, yet penetrable to the slightest whisper—adapting itself with admirable facility to the loudest thunder, or the roaring of artillery—to the softest breathings of music, or the tender utterance of affection!

The same adaptation which is observed in the eyes of different animals to fit them for their several wants, is also apparent in the organ of hearing. Those animals which pursue their prey by night, and are consequently much guided by the sense of hearing, have many more, and much larger, muscles to move their ears than man has. Animals, also, which fly from pursuit, such as the sheep, deer, &c., are possessed of the same advantages. In animals of the whale kind, and most others which dive in the water, a valve is placed within the aperture of the external ear, to moderate the pressure of water upon the drum; and the aperture itself is of a tortuous shape. Birds and fishes also have peculiarities, constructed according to the wants of their possessors.

THE NOSE.

This is a more important door of the human habitation than may be at first supposed. All, or nearly all, animal and vegetable bodies are constantly emitting

small particles, the quantity of which, when they are received into the nose in its healthy state, can be readily detected. This is undoubtedly one great purpose of this organ, and especially of its curious internal structure; and in order that the nature of bodies, of whose particles the air is constantly full, may be readily detected, the interior of the nose is of very ample dimensions.

The form and appearance of the outer portion are well known. Its upper half is composed of bone covered with integuments, and the lower half of cartilage, with the same addition, divided into two portions by a bony and cartilaginous partition down its middle, the whole of which is moved by various muscles. The nostrils run backwards in nearly a horizontal position, to terminate in the throat, and their whole surface is lined with a thick spongy substance, closely adherent to the periosteum, and plentifully imbued with a mucous secretion, in the soft bed of which is distributed the innumerable ramifications of the *olfactory nerve.* Still further to increase the capacity of smelling, and to admit of an enlarged surface upon which the nervous filaments may spread, the bones within the nose contain many irregular shelf-like projections; in addition to which, in each cheek-bone there is a hollow cavity, of size sufficient to hold a table-spoonful of fluid, which communicates with its interior. There are also cavities in the forehead, just over the inner angles of the eyes, which in like manner open into the same receptacle.

Over the whole of this extensive internal surface is

spread the olfactory nerve, though not to so great an extent in the remoter parts as it is in that which may more properly be called the nose.

It is extremely probable that, in a more *natural* state of life, the organ of smell would be enabled to detect all substances of an injurious nature. Most animals are endowed with this property, rejecting whatever is noxious to the species, and, doubtless, savage nations partake more or less of this qualification: how else would their lives be preserved, surrounded as they frequently are with poisonous leaves and roots, and often urged by excessive hunger?

Those who do not accustom their nostrils to strange mixtures of scents, to the narcotic properties of snuff, tobacco, and things of that kind, and to spirituous potations, the whole of which immediately injure the organs to which they are applied, and indirectly affect the functions of the whole body, may hope to enjoy the sense of smell, in common with other faculties, which naturally diminish by age, to a much greater extent than those who abuse them by indulgence.

There is yet another purpose which the nose fulfils, connected with the voice, and with respiration. If we hold the nose tightly, so as to prevent the transmission of air, and then speak, or sing, we find that the sound is materially altered—in fact, becomes quite disagreeable, and of a nasal character. These chambers, then, or hollow spaces, serve as vaulted arches, through which to reverberate the sound, and modify the tone; of a somewhat analogous nature to the sounding boxes, or boards, placed over the pulpits in churches.

THE MOUTH.

This is, in many respects, the most important door of the human frame. For, if the nose should cease to perform its office, we could supply its place, in some measure, by the eye, the ears, and the touch. The same is true of the ear, and even of the eye. But if the mouth were to fail—if this door were closed for ever—there is no substitute. We may, indeed, receive a part of the supplies necessary to our existence (I mean air) through the nose; but a far greater part could not be received even in this way; and the frame would soon decay, and mingle with its kindred dust.

There has, I believe, been but one complete instance recorded, in which an effectual substitute for the mouth was provided. Several years ago, a young Canadian, by the name of Alexis St. Martin, was wounded by a musket-ball, which shot away part of the flesh of the side, and wounded the stomach. When he recovered, an opening was left, somewhat like the mouth of a purse, directly from his left side into the stomach. So complete was this artificial mouth, that notwithstanding the natural delicacy of the part, food and drink could be introduced into it through a pipe; and, if care were used, it could be done without pain. The contents of the stomach—the fluid contents at least—which had been swallowed by the mouth, could also be let out at any time; and, indeed, a piece of solid food, if a string was attached to it, could be withdrawn, and re-introduced at will. Some curious experiments on digestion were performed in this way.

I have seen Alexis once myself; and have witnessed what I state. But this is perhaps a solitary case; I do not know that any other case of the kind ever existed, and most probably never will again.

The particular structure of the mouth—curious as it is—is so well known, that it does not seem to require a particular description under this head. When I come to speak of the apartments, and especially of the furniture and employments of the House I live in, I shall have occasion to say more about it. It was only necessary to mention it here as a part of the covering, and for the sake of method.

Chapter XIV.

APARTMENTS AND FURNITURE.

Having mentioned and described some of the doors and windows of the House I live in, and spoken of the rooms contained in it, it is necessary to call your attention to one essential and important difference between it and buildings erected by human means. The rooms in many dwellings are often partially or entirely empty; or at least there is nothing in them excepting a small quantity of furniture, and the air. But excepting a few very small and not very important apartments, all the rooms of my House are completely filled. Such a thing as empty space is hardly known in them. The furniture, or whatever else they contain, at all times completely fills them; for when anything is removed, their walls are accustomed to shrink accordingly; and when anything is introduced into them, these walls have the power of gradually yielding, so as greatly to increase the capacity of the apartments.

It is true that the furniture, &c., in each room, does not so entirely fill it as not to leave place for air, for, as I have already said, all the various rooms of which I am now treating, have communication with the open air, in such a manner that, in a small quantity, it can reach them.

But it is time for me to speak of these apartments with more particularity. I have already shown you

that all the cavities, or passages in the human body which open to the air, such as the ears, nose, and mouth, are lined with a membrane of the same quality as the skin, only much thinner. It has its thickish layer, or real skin, on a delicate cellular cushion; then its soft thin layer of pigment or paint, if this has any existence beyond the commencement of the openings, as at the edge of the lips;* and, lastly, its cuticle.

This membrane is not usually called skin, however, till it arrives at the surface. Its usual name is *mucous membrane,* because it everywhere *secretes* on its surface more or less of a fluid substance, which is called mucus.

EXTERNAL EAR.

The passage into the ear, as we have already seen, is lined with this membrane. But the passage or cavity is so small, that it can hardly be called an apartment. The cavities connected with the nose are of much more consequence.

CHAMBERS OF THE NOSE.

These, as we have seen, are the hollow, but very irregular passage of the nose itself; the cavity in each cheek bone; and the cavity in the forehead, on each side of the root of the nose. All these cavities are *real* cavities; for they are situated in hollows in the

* Anatomists are not agreed on this point. The general opinion is, that this membrane which contains the colour, does not exist at all in the internal cavities of the body.

bones, and therefore the sides cannot fall together and close up the space.

All these cavities, moreover, become in some cases the seat of painful diseases. The nose is subject to the polypus—a pear-shaped swelling, with usually a narrow neck. This sometimes renders breathing very difficult; and, if not extracted, has been known to extend further, and become the means of destroying life, and even if it be removed, it is very apt to grow again.

Painful diseases also occasionally arise in the cavity of the cheek-bone, which are sometimes mistaken for tooth-ache: the extraction of the tooth which appears to cause the pain, unless its roots extend quite through into the cavity, thus giving exit to the *pus* or matter which has formed, in general affords no permanent relief. Some kinds of headache have their seat in the hollows of the frontal, or forehead bone, near the root of the nose. A very common disease in sheep is known to be produced by worms being contained in these hollows, which are produced by some of the species of flies depositing their eggs up the noses of the animals, where they are hatched by the heat. The dull heavy pain so often felt over the eyes, especially when we have what is commonly called a cold in the head, is owing to a slight inflammation of the lining membrane of this cavity.

We ought to be cautious in smelling substances which cause much pain; and, probably, the too frequent use of smelling bottles and pungent scents is, in the end, injurious to the extremely fine and deli-

cate lining of all the "rooms" connected with the nose. Much snuff certainly is, and so is the smoking of tobacco and cigars, and the chewing of opium —practices so common in most Eastern lands, and which are too frequently indulged in, even in this country, by the thoughtless epicure and the fashionable fop.

THE MOUTH INTERNALLY.

The mouth of itself is one of the apartments of the human body, and a very curious apartment too. When I spoke of it as being one of the doors, I referred more particularly to the aperture formed by a cleft of the lips, or the external mouth, and not to the *internal* or more important part.

In this chamber, the entrance chamber of the front door, we find the teeth, the tongue, the palate, and several small glands. This entrance chamber is larger than the hall or space beyond it, from which doors also open into several other apartments.

I described the nature and uses of the teeth in a former chapter; the tongue, therefore, next demands our attention.

THE TONGUE.

This muscular organ is supported by a bone of a horse-shoe form, situated in the throat, by means of which it is connected to the various muscles which put it in motion, and which form part of its substance, and by which also it is attached to the adjacent parts. It

is covered with a continuation of the outward skin, the upper surface of which is thickly covered with little eminences called *papillæ*, which, when any sapid body is applied to them, seem to erect themselves, as it were, to meet it, and are a very principal feature in the formation of the *taste*,—in this it is assisted by the palate, and some other parts of the great cavity of the mouth.

THE SALIVARY GLANDS.

The bodies which perform the office of secreting the saliva are very numerous: there are three, however, on each side, which are larger, and more essentially concerned in the function than the others—namely, the *parotid*, the *submaxillary*, and the *sublingual glands*. The principal of these is the parotid, which lies beneath the ear, close to the angle of the lower jaw, a large duct from which, penetrating the muscles of the face, enters into the mouth between the second and third molar teeth of the upper jaw. The submaxillary gland is smaller than the last, and, as its name implies, is situated on the inside of the angle of the lower jaw, the passage from which, running through the muscles of the face and tongue, perforates the membrane of the mouth, just on the side of the little bridle which is visible under the tip. The sublingual gland is yet of less dimensions than the submaxillary, is found under the front sides of the tongue, and has various minute openings at the inner side of the lower gums.

All these glands secrete a fluid, called *saliva*, which

is of great service in digestion; this, mingling with the morsel under mastication, facilitates the process, aids deglutition, and prepares the food for the grand operations of the stomach.

PASSAGES TO THE EAR.

Further on, in the upper and back part of the mouth, are two doors of considerable size, connecting with the chambers of the nose; and in the same region the passages begin which lead to the middle cavity of the ear, which has been already mentioned, called the tympanum; but enough has been said about these various apartments in another place.

A little behind the root of the tongue is an opening, whose structure has a strong resemblance to what is usually called a *trap-door*. It leads to the lungs or breathing apparatus, occupying a very large upper apartment of the body, and is one of the most curious parts of the human system. No real gate, or door, set on hinges, and guarded by an active and intelligent porter, could better answer its intended purpose.

I have said that there is a strong resemblance here to a trap-door. The passage to the lungs, where it commences, is a mere slit; though, it is true, it very soon becomes larger. Over this slit is placed a lid or flap, called the *epiglottis*, not unlike the tongue in shape, but of course much smaller, which fits to the opening as exactly as a trap-door was ever fitted to its frame.

It is not usually shut, however, except when we

attempt to swallow. Then the substance, and the motion caused by this operation, press it down, and close it perfectly tight; and it is well that it is so; for if it were not, the food would often drop into the passage to which this trap-door opens, and create great inconvenience, and probably disease, and even death, might ensue. How painful this is, may be remembered from the irritation which is felt when a crumb of bread, or other small body, may, as is commonly said, "go the wrong way!"

THE CHEST.

Beyond the door the passage greatly enlarges, and proceeds downwards into the chest—that large apartment in which the lungs and heart are contained. This apartment is one of the most capacious in the House I live in, and nearly fills the upper story, and is one of those which has no outer doors, neither is it connected with any other cavity or room. It is supported on all sides by strong bony walls, having the breast-bone in front, the back-bone behind, and the ribs at the sides. Above, at the fore-part of the neck, it is of course less guarded with bone, and at the bottom there are no bones at all. It is separated from the second, or lower story, by a strong membranous muscle, called the *diaphragm*, or midriff, a large muscle, which completely divides the cavity of the chest from that of the abdomen, and is greatly concerned in the function of respiration.

CAVITY OF THE LUNGS.

The trap-door of which I have spoken does not lead directly into this large apartment, but into a bag or sack, called the lungs, which lies within, and nearly fills the entire space. It is divided into two portions, one on the right side, and the other on the left. The passage from the doorway at the top of the throat into the lungs is at first tolerably large, and its projection may be both felt and seen externally. It appears, at first view, to be a long bony tube; but it is not so, being composed of firm cartilage, almost as hard as bone. Soon after it gets fairly within the chest, it ceases to be cartilage, and becomes degenerated into nothing more than common membrane.

This passage or pipe is composed of about sixteen or eighteen cartilaginous rings, varying a little in number according to the length of the neck. Each of these rings forms a large segment, or nearly two-thirds of a circle, which are united to each other and to the channel for the food, which lies behind it, by an elastic ligamentary substance, and the tube remains constantly open for the transmission of air.

At the top of this tube, or, as it is called by anatomists, the *trachea*, is a firm cartilaginous box—the visible projection of which I just mentioned,—containing the apparatus for producing the voice; but of this I will treat more fully in a short time.

The trachea having arrived in the chest, divides

into two channels, like the trunk of a tree when it divides into two main branches, and are named the *bronchi*, one of these passing to the right side of the lungs, the other to the left. Soon each of these parts divides again, and thus continue to divide and subdivide, until, after a short space, the branches become as numerous as the boughs of the thickest tree, and becoming gradually smaller, they at length form a countless number of capillary tubes, which terminate in the cells of the lungs—extremely small in extent, but having free communication with each other.

The lungs are two bodies of a soft and spongy texture, which fill nearly the entire cavity of the *thorax*, or chest, and are each separately contained in two bags, made of the lining membrane of the ribs, and called the *pleura*. Thus situated, they are described as the right and left lungs; they act independently of each other, and have no communication, excepting by the common passage through the windpipe. Each of these divisions is formed into large portions, or *lobes*, three belonging to the right lung, and two only to the left, the heart in the latter occupying the place of the corresponding lobe on the opposite side. Each of these masses becomes subdivided into lobules, which, gradually diminishing, terminate in the membranous air-cells, which make up the chief substance of the organ; the whole of which is somewhat conical in shape, and in colour approaches to a blueish-grey.

I will now proceed to speak a little concerning the production of the *voice*.

That part of the throat-pipe which is principally concerned in the formation of the voice, is called the *larynx*, and is situated towards the upper part of the tube, and becomes very visible when the head is thrown backwards, forming an obvious projection—more particularly in males. This larynx may be compared to a box, and is formed of several pieces, which are made of cartilage, and are five in number. That which composes the upper and fore-part, being by far the largest, is called the *thyroid* cartilage, or sometimes the shield-like cartilage, from its supposed resemblance to that piece of armour. From its upper and posterior corners, a ligament extends, which unites it with the bone of the throat, (*os hyoides,*) before mentioned. At the bottom of this portion of the larynx another cartilage is placed, the *cricoid,* and there are two others at the sides. In this box are contained four ligamentous cords, which are called the *vocal ligaments*, and the opening which is left between them is the *glottis,* an opening appearing like a triangular slit, widest at the back part; upon the due expansion or contraction of which, aided by the operation of muscles, the tone of the voice depends.

When the chink of the glottis is narrowed, the voice is acute or shrill; and when the chink is wider, it becomes grave or low in quality.

I have yet mentioned only four of these cartilages, the description of the fifth is still due. This, known by the name of *epiglottis,* is situated at the top part of the box, is of a very elastic nature, and of a somewhat

oval form; being attached to the root of the tongue, it is pressed down by the action of that body during the effort of swallowing, shutting up the glottis, and completely defending it from intrusion of the food. It also serves to regulate the current of air into the box. This is the very same *trap-door* of which mention was made a few pages back.

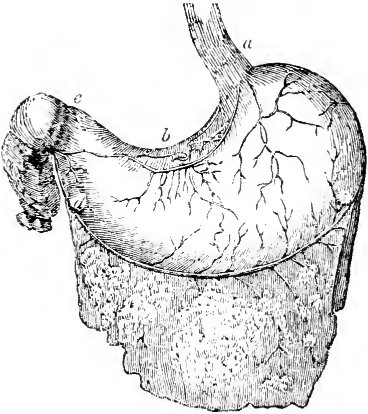
THE FOOD-PIPE, OR ESOPHAGUS.

The back part of the mouth, where the food-pipe, or passage to the stomach, commences is funnel-shaped, but the passage or food-pipe itself is tolerably regular in its form. This muscular canal proceeds downwards, close upon the spine, behind the wind-pipe, and at the back of the heart, till it has fairly passed the apartment of the chest, and then it enters the borders of the great apartment below, which occupies the lower story of the building. When it has reached the confines of this apartment, the passage enlarges into what, keeping up the same analogy, may be called a spacious saloon.

THE STOMACH.

The human stomach, resembling in shape the Scotch musical instrument called the bag-pipes, lies with its greatest length directly across the body, immediately under the diaphragm, just within the edge of the ribs, and is composed of muscular and membranous coats. The place where the gullet enters is called the *cardiac orifice,* and the termination or outlet of this

spacious saloon is named the *pylorus*, or pyloric orifice, a most important situation, the meaning of which word will be explained hereafter. This viscus is abundantly supplied with blood-vessels to fit it for the grand offices of life which it is destined to perform, and its capacity, when moderately distended, is about two or three pints.



In this representation of the human stomach, the letter *a* represents the lower part of the gullet or food-pipe; *b*, the upper or concave surface of the viscus; *c*, the left, or large extremity; *d*, the end, or small extremity; and *e*, the pylorus.

THE INTESTINES.

From the pyloric extremity of the stomach, the intestines commence. These consist of a long cylindrical canal, which, winding about in different directions to the extent of about six times the length of the whole individual, at last terminates in the inferior outlet of the body. The largest proportion of the entire *abdomen*, or great internal cavity of the human frame, is filled up by the intestines, which are divided into large and small, according to their size.

The *small intestines* form the commencement of the passage, the upper portion of which is named *duodenum;* this, first making a short turn upwards, and a little backwards, turns upon itself in a downward direction, and towards the right side. When it gets so low as to be opposite the lower side of the right kidney, it turns to the left, and crossing the spine, receives the name of *jejunum*, so called from being generally found in an empty state; thence, forming numerous convolutions or folds, it at length acquires the appellation of *ilium*, which name it retains for about three-fifths of the length of the whole small intestines.

When the *ilium* has performed a certain number of convolutions, and has arrived at the top of the right haunch-bone, or os ilium, it enters into the first of the—

LARGE INTESTINES.

The colon is the first portion of the lower or large bowels which unites with the upper, and this junction is effected in a very curious manner—a moveable valve or flap being placed across the opening. Just under the part where the union takes place, the gut dilates, forming a bag, or pouch, with its concavity downwards, three or four inches in length, and about the same in width, which lodges in the cavity of the haunch-bone on the right side. This pouch has received the name of *cæcum*, and from it projects a portion of bowel, about three or four inches in length, something like the finger of a glove in shape, though much smaller in diameter, called *appendix vermiformis cæci*, and which, being impervious at its lower end, nothing can pass through it. The colon, continuing its course, in diameter much larger than the small intestines, ascends upwards on the right side, as high as the top of the kidney, and crosses the abdomen just under the stomach, and over the duodenum, under the name of the *transverse arch of the colon;* from thence, turning a little backwards, it descends down the left side, and forms two convolutions, in shape like the letter S, being the *sigmoid flexure*, and then, assuming the name of *rectum*, continues in a straight direction to its outlet.

Lying in front of, and spread out over the intestines, and continuing from the stomach, as seen in the plate at *g*, is a fatty membrane; this is called the

omentum, or caul. This membrane also dips between all parts of the bowels, enveloping them as in a bag, under the general name of *peritoneum*, and serves as a medium of communication from the blood-vessels of one portion of the intestines to other parts of the same canal. It also contains glands which are subservient to the nutritive processes going on: and it is also supposed, by its thickness, to assist in preserving the proper temperature which is necessary to be maintained for the performance of the highly important functions which are here almost constantly in operation.

GALL-BLADDER.

Under the large lobe of the liver is situated the gall-bladder, which, as its name implies, contains the gall or bile. Not far from the stomach, there enters from it into the intestines a duct, or pipe, which conveys the bile to the *chyme*, or food which has undergone the action of the stomach, and materially assists in the nutritive process.

The gall-bladder is about as large as a man's thumb, or sometimes larger. In the same neighbourhood is the pancreas or sweet-bread, between which and the main passage through the body there is also a communication, though its use is not precisely ascertained.

In this lower story of the House I live in—the *abdomen*—there are several other apartments besides those I have already described, some of which open externally, and others do not, but which need not

be very particularly specified. I must now describe another class of apartments—those which do not have communication with the air.

One of these has already been mentioned—it is the cavity of the chest. Another is the cavity of the cranium, or bones of the head. Others still are in the central parts of the brain, or contents of the cranium. The last, but most curious and most important, which I shall describe, is the great cavity of the circulation; I mean the circulation of the blood.

APARTMENT OF THE CIRCULATION.

This is a larger apartment than many would first suppose. It must of course be large to contain, as it does, twelve or fifteen quarts of blood. It may be compared to two great underground reservoirs, formed by the union of thousands of large or smaller (but most of them very small) streams, running side by side with each other, and in an opposite direction; and which, having no communication with each other in their course, so they have no outlet—at least none of any considerable size.

To talk here about the circulation of blood, when my professed object is to describe a chamber, may perhaps seem out of place; but to me it appears indispensable. For such is the irregularity of this circulatory apartment, that it is next to impossible to describe it in any other way than by telling you something of its course and its contents. But I will be very short.

You may first think of all these streams as if they were filled with blood; and afterwards, imagine them as if emptied of their blood, and hollow. In the latter case, if a quantity of liquid, such as water, or melted wax, or even blood, were thrown into the cavities of the heart by means of a syringe, and if considerable effort were made, the liquid thrown in would soon run into all the large, and even the small, branches of this multiplied channel, or apartment, and fill it entirely; and the amount it would contain, as I have before intimated, would be in an adult about three or four gallons, or equal in quantity to a common-sized pail-full.

Thus you see that, though the apartment of the circulation is strangely irregular, it is nevertheless a very spacious apartment; and has been considered as almost, if not quite, equal to the whole cavity of the chest, in which the lungs and heart are placed; and not much inferior, in point of size, to the cavity below it, that of the abdomen.

But I must tell you here something more of that part of the circulatory department which lies in the heart itself, or in what may be called the little sea or lake, into which all these unseen rivers constantly pour their various crimson floods.

The heart has really four cavities within it, two on the right side and two on the left. The blood which has been sent into all parts of the body through the arteries, returns to the first or upper part of the right side, the auricle, and then passes through into the right ventricle. As soon as this ventricle is full, it

contracts, and presses its contents, the blood, into a great artery, called the pulmonary artery, which carries it to all parts of the lungs, whence it comes back into the left side of the heart; first into the left auricle, and next into the left ventricle. From the latter it is discharged, when the heart contracts, into the great artery, or aorta, and distributed all over the body.

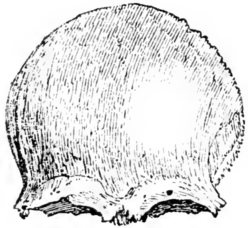
These four small cavities in the heart together hold, in an adult, about three or four ounces of blood. The length of an adult heart, measured on the outside, is about five inches, or we may say, in general terms, that it is about the size of a man's fist.

A great deal more is to be said about the heart—its cavities, structure, motion, situation, &c., but I have mentioned all that is necessary, in this part of the work, to give a general idea of the circulatory apartment.

CHAMBERS OF THE BRAIN.

Before I describe these, I must say something more of the brain itself, though I have partly described it in a former page.

Here is a picture of some of the bones of the cranium—those which contain the brain. It is the same plate which you saw at page 56, but, for the sake of convenience, I have introduced it again in this place.



The brain, then, is a somewhat soft, pulpy mass, which, with its envelopes, fills up the entire cavity of the skull, and in colour and general appearance is not unlike those of domestic animals, but considerably larger in proportion to the size of the body.

To possess a more accurate idea of its exact size, however, take a piece of twine and tie it round your head, from the bottom of the eye-brows or edge of the forehead to the nape of the neck, letting it come down close behind the root of the ear. Now all above this string, except the skull itself, and the skin, flesh, hair, &c., is brain; and the whole covering, bone, flesh, skin, &c., can hardly be more than half an inch thick in the thickest part, and in some places scarcely a quarter of an inch; so that there is a very considerable quantity of brain, as you perceive. There is even a *little* brain below the line of the string, but not much, unless that may be called brain which runs down into the hollow cavity of the spine, like a large whitish cord, and which I have already told you is the spinal marrow.

The substance of the brain is usually described by two names; the upper and front part, which is by far the largest, is termed the *cerebrum*, and the posterior and lowest portion is named *cerebellum*, both of which, being united together, are closely and firmly enveloped in three distinct membranes or coats; and the whole weight of which, in an ordinary-sized man, is about three pounds.

The cerebrum is divided by a prolongation of the outer and strongest covering of the brain, for a short distance down its perpendicular extent, into two portions, or hemispheres, which are of a somewhat oval shape, and convex on their upper surfaces; at its lower part it separates into six lobes, two in the front, two at the sides, and two at the back part.

The whole surface of the brain is divided into several fissures, which are made up of a multiplicity of convolutions or windings, into which the thinnest of its coverings everywhere dips, and, from its protecting nature, continued presence, and delicate texture, is named the *pia mater*, or tender mother, in contradistinction to which the outward, tough membrane last spoken of, is called the *dura mater*, or firm mother.

Of all the intricate parts of our wonderful frame, none is more apparently complicated, and the functions of no part so little understood, as the structure now under consideration. Anatomists have at all times made it a peculiar object of study, and although the greatest research, the most extensive experiments, and the most untiring industry have been displayed by its cultivators, yet victory has hitherto eluded their grasp.

From the boundless labour which has been bestowed upon this part of the internal economy, great accuracy of anatomical detail has been acquired, and a profusion of names given to its various differences, real and imaginary, but from a sound physiological view of its operation we seem as far remote as ever. That it is intimately connected with sensation, motion, digestion, in short with every function in the body, by means of its nervous communications, we are sure of; but how these results are effected, and from what special part of the cerebral mass each derives its influence, we must remain content at present to be unable to explain.

In an organ intricate and so delicate as this is, it would be absolutely impossible, without the aid of many plates, to convey any idea of its separate parts, and even with their help, the general reader would glean but little information. It will be sufficient here, in addition to what has been described, to mention that the brain is divided throughout its extent into two substances, of a somewhat different appearance, termed the *cortical* and the *medullary* portions, of which the former is situated the most outwardly, and is of a greyish colour, and the latter approaches more to white. It is from this last—the medullary portions—that the different nerves take their origin.

Besides the larger portion of the brain, the *cerebrum*, above described, there is the *cerebellum*, or, as it is sometimes called, " the little brain." This is situated in two cavities in the base of the occipital bone, or that bone of the skull which lies at the back and lower part, and is in size about one-sixth part of the brain,

properly so called. It partakes of the same general appearance as the rest of the structure, but is apparently less complicated.

As we have been pursuing an analogy to the chambers in a dwelling, the parallel may also here be carried out, for the brain contains several cavities, or, as they are called, *ventricles*, of which there are four, though some anatomists also add a fifth. These, in the natural size, are exceedingly small, yet when, by the operations of disease, they become distended, they enlarge to an enormous size, and being filled with an aqueous fluid, they exhibit that formidable malady commonly known as "water in the head," or *hydrocephalus*. To what particular purposes these ventricles are subservient, we cannot say; but without doubt they have specific duties allotted to them.

One of the chambers in the interior of the brain was supposed, by the philosopher Descartes, to be the particular residence of the spiritual inhabitant; and many other parts, by fanciful speculators, have been assigned as the seat of the soul. These theories have long since been abandoned as untenable; and I can assure the reader with certainty, that my immortal spirit does not reside exclusively in any one part. It lives in all parts of the brain, spinal marrow, and nervous system in general, and they may all be considered as simply an extension of one great and important central communication, which forms the connexion between the material organization and the mental phenomena.

NERVES.

From the base of the brain, nine, or, as some say, ten, pairs of nerves take their origin; of which that pair lying towards the front of the head is named the *olfactory nerves:* these, piercing the skull through a number of small apertures, divide and subdivide into innumerable minute filaments, which distribute themselves over the whole interior of the nose, and form the organ of smell.

The second pair, which lie behind the last, are thicker and rounder in substance, and proceed towards the eyes, under the name of *optic nerves*, to form the peculiar seat of vision, the retina.

The third pair, smaller than the last, are distributed to the muscles of the eye-balls.

The fourth pair come next in order; these are the smallest trunks of nerves in the whole body, and are chiefly dispersed over the superior oblique muscle of the eye.

Proceeding still backwards, we find the largest nerves in the brain, the *fifth pair*, or *trigemini*, each having three separate branches on each side. The *first of these branches* ramifies over the forehead, upper eyelid, and nostril of the same side, and, penetrating the eyeball, forms the minute ciliary nerves; *the second branch* supplies the upper jaw, the palate, and the contiguous parts, while the *third branch* is found meandering among the muscles and glands of the lower jaw.

The sixth pair chiefly supplies one of the muscles of

the eyeball. Next in the backward order is a very important nerve—*the seventh pair*—which is composed of two portions, called the *portio mollis,* and the *portio dura.* The portio mollis, entering into the internal part of the ear, splits into several divisions which form that soft and pulpy nervous texture which I have before explained as lining the several parts of the labyrinth, and is the medium by which sounds are received. The portio dura sends its branches to the muscles of the internal ear, the parotid gland, the muscles of the face, and the adjacent neighbourhood.

The eighth pair is another nerve of great importance in the human economy. After sending twigs to the back part of the throat, root of the tongue, &c., it descends down the neck in common with the main artery, (the carotid,) and, joining the great sympathetic nerve, is distributed to the substance of the heart.

The ninth pair are the furthest back of any which have been mentioned, and principally supply the tongue, and the muscles connected with it.

There is yet another influential nerve, which, though not, strictly speaking, having its origin directly from the cerebral mass, is yet so nearly connected with it, that its consideration ought to come in this place. I mean that nerve which, from its communication with almost all the rest of the nervous system, and from the magnitude of the office which it fulfils, is truly described as the *great sympathetic.* This nerve, being formed by filaments from the fifth and sixth cerebral nerves, and uniting with a branch from the eighth, and also with several of the nerves of the neck, extends

downwards by the spine, enters the cavity of the chest, and afterwards of the abdomen, where, distributing itself to all the viscera contained therein, it associates all the several functions, and conveys their united sensibilities to the brain.

It is by the special operation of this nerve that disturbances in the function of one particular organ are often painfully felt in remote parts, they, as it were, sympathizing with the afflicted spot; hence the name great sympathetic.

Next in order come the spinal nerves. In the sides of the pile of bones called the spine, are apertures all along from the top to the bottom, which are formed by notches in each vertebra. There are also six or seven pairs of holes, similar to these, through the sides of the strong bone below, on which the spine stands, and through each of the whole of these run large branches of the spinal marrow. These branches or cords are whitish, like the marrow itself, and like the brain, and their number is about thirty on each side, parting into branches almost innumerable, and distributing themselves to nearly all parts of the body. The nerves divide as minutely as do the arteries and veins, which is proved by the fact, that we have feeling almost everywhere within us.

A puncture with the point of the smallest needle gives us pain, but this could not be unless there were nerves in the part which is wounded. They are so numerous, that if there were any way of destroying all parts of the human body, excepting the nerves, without in the slightest degree injuring or displacing the

latter, they would present a large mass, generally resembling in shape the complete and perfect living body. The arteries—the vessels which carry blood from the heart to all parts of the body—if all else were destroyed, would present the same appearance; and so also of the veins.

There is, however, one important difference between the nerves and the blood-vessels. The latter are all hollow tubes, but the nerves are not known to be so. Some have supposed that the little white pulpy threads or fibres of which they are all made up are hollow; but this is not generally admitted.

Now the uses of these nerves are to convey sensation from the various parts of the body to the brain, which may be considered as their common centre. I have just told you that nine pairs of nerves emerge from the base of the brain. Now the uses of these are to convey the various impressions of sight, hearing, smelling, and some other functions connected with the *expression* of the countenance. If by any accident, disease, or surgical operation, the communication between the extremities of any one of these nerves and its connexion with the brain were destroyed, the function which that nerve performs, whether of seeing, hearing, &c., would be almost entirely suspended.

In like manner, the thirty pairs which are connected with the spinal marrow, from its junction with the head to its termination at the pelvis, carry sensations of pleasure or of pain; and also give the power of motion to the muscular parts of the body.

To effect these purposes, each of the larger nerves,

though apparently single, are divided at their roots into two portions; one of them is the medium by which the impressions of feeling &c. are communicated, and the other serves the purpose of giving motion to the muscles it supplies; and these two portions of the nerve are bound up, as it were, so intimately together, during the whole of their course, that no difference can be perceived in them.

Here, then, we see the reason why, in some diseases of the human frame, the power of motion is destroyed in a part, while feeling and sensation remain entire; and why the voluntary movements are not at all affected in others, when the capability of receiving pain, or the impression of touch, are annihilated.

Chapter XIV.

FURNITURE OF THE HOUSE, AND ITS USES.

We now come to the furniture of the House I live in, and its various uses. This will make a long, but, I trust, an interesting chapter.

Here, however, our similitude begins to fail; for while the House I occupy, like all other houses, is liable to waste and decay, there are in the human habitation certain pieces of furniture — machinery, perhaps I should say — by means of which, under ordinary circumstances, repairs are constantly going on, equal, at least, to the waste. But in no ordinary dwelling can any such process be found. All dwellings can indeed be repaired, but usually by external aid, and not by any operation of their own from within.

The habitation of the human soul is kept in repair principally, by means of the rivers which run through the circulatory chamber, and it was this fact that made it necessary for me to dwell so long upon this apartment in the previous chapter.

THE BLOOD.

There is nothing in the whole universe which so much resembles the economy of the human body, showing the means by which its constant waste is supplied, and the whole kept in repair, as the manner in which water is conveyed to the surface of the earth.

Evaporation and the growth of plants, with the demands of the animal creation, are constantly wasting and drying up the soil: but there are numerous hidden streams, some of them very small, that wind their way in almost every direction, and continually furnish new moisture.

It is true, there are also large streams which appear on the surface, very different to what takes place on the outside of the human body; neither is it to be forgotten, that the earth is watered in part directly from the atmosphere. Yet, with these deductions, there is still a general resemblance between the two great processes. The one constantly recruiting the wants of a world: the other supplying the demands, and repairing the waste, &c., of what, for the sake of its near relation to the immortal inhabitant, is worth far more than any known globe.

PREPARING THE BLOOD.

But how is this blood, flowing through its tens of thousands of crimson streams, prepared and supplied to the human body? for it must be first *made* before it can be supplied. Indeed, a most curious and really wonderful process is this, and one which demands a particular description.

MASTICATION, OR CHEWING.

I have already told you about the teeth, their number, their uses, &c. They are principally designed for breaking down and grinding the food,

the material from which the blood is to be made; for the great Author of our frames has so ordered, that after a certain degree of waste has taken place in the system, a feeling of necessity for its reparation arises within us, which we call hunger; and in the gratification of which much pleasure is experienced. And in order to gratify that hunger properly, and accordingly to recruit the waste of the body, which is continually proceeding, there is that duty for the teeth to perform, of which I have just spoken.

But while the teeth are breaking down the food into smaller pieces, the salivary glands, described in another place, are continually secreting, and pouring through small tubes into the mouth, a quantity of *saliva*, just sufficient to moisten, and render the mass somewhat of a pulpy consistence: the other little glands also, lying under the tongue, assist in this work.

When the food is beaten fine, and sufficiently moistened, it is gathered together upon the tongue, and by a series of curious movements, which I have not room in a work like this to explain, it is pushed along beyond the root of the tongue to the top of the gullet, or food-pipe, whence, by muscular action, it is conveyed downwards into the stomach. In its passage towards this receptacle, it passes directly over the trap-door of which I have already spoken; and were not this little flap most accurately fitted, and most ingeniously contrived to effect its purpose, we should often be in the greatest danger of suffocation; for in speaking, coughing, or laughing,

while the food was in the act of being conveyed into the stomach, it might perchance descend into the air-passage, or *trachea.*

TRAP-DOOR.

It is true that this door usually closes, when any substance approaches, almost as quickly as I formerly told you does the eye, when anything comes too near to that organ; but it is also true that, as in the case of the eye, it does not always close quite soon enough, and substances actually do fall into the trachea. When this accident happens, great irritation and coughing is produced, by which, at length, the offending body is frequently expelled. When this speedy dislodgement does not take place, the coughing generally subsides, and if the substance is a morsel of bread, or other food, it shortly dissolves; but if it be of a hard or tough nature, as a piece of bone ör wood, it usually creates great pain and inconvenience, and, unless it can be removed by mechanical aid, or by a surgical operation, often ends in death.

While writing this chapter, I have read, in one of the medical journals, of a little girl, five years of age, who, in playing with a brass nail, was so unfortunate as to have it fall into her windpipe. It produced a little coughing, and then all was quiet, and the parents and friends thought all danger was over. More than a year afterwards, on taking cold, there came on a severe cough, with hectic fever, night perspirations, and bleeding from the mouth: she died

of a rapid consumption; and, on opening her body, the brass nail was found imbedded in her lungs.

I hope that every young person who reads this account, will avoid holding nails, pins, buttons, and other such things, in the mouth, as well as all laughing and talking while eating; for it is at the least always dangerous, and may probably prove fatal.

When the food is fairly beyond the tongue, and has passed the little trap-door, it goes into the top of the food-pipe, as into a sort of a funnel-top. Below this, the pipe becomes smaller; but if we eat and swallow slowly, not so small but that the food will pass readily; but if we do not properly masticate our food, or if we swallow it too rapidly, it is sometimes retained in the passage, causing great inconvenience, and even requiring an operation to dislodge it. Many individuals have very nearly lost their lives by a large piece of meat, or other unchewed substance, remaining in the gullet, and only by surgical aid was the danger averted.

DIGESTION.

The food, however, arriving in the stomach, remains a short time, gradually softens, and becomes converted into a greyish or whitish pulp, called *chyme;* the formation of which is materially promoted by a fluid called the *gastric juice.* This fluid does not travel a long way through pipes, like the saliva, but seems to ooze, as it were, from the inside of the stomach in large drops, as you have seen the drops

of water or sweat from the forehead of a labouring man in a hot day: and this process is called *secretion*. When the outside of the mass which is in the stomach — that part in contact with its sides — becomes softer, it is slowly conveyed, by a curious motion of this receptacle, to its right and lower extremity, which I have already told you is called the *pylorus*, by which term is meant the door, or outer gate of the stomach, or, as some call it, the door-keeper. It may well be called a door-keeper, for it really does seem to exercise a sort of choice; for, if anything presents itself there which is not proper to be conveyed into the system, or not well adapted for making blood, it does not, for some time, suffer it to pass; though, after the substance has repeated its efforts a great many times, it appears to yield, as if to importunity. True chyme, made of good and proper materials, it never refuses, but suffers it to go at once into that portion of the intestines which joins to the stomach, called the *duodenum*. The outside of the mass of food in the stomach having been subjected to the process just named, that portion immediately under it is submitted to the same treatment, and so on, till the centre portion is brought into contact with the gastric juice, and the whole converted into grey, pulpy fluid.

FORMATION OF CHYME.

Arrived in the duodenum, it becomes a still more perfect chyme, and is gradually mixed with a bitter fluid, the *bile*, which comes through a small pipe from

the liver, and also with a liquor resembling saliva, proceeding from the *pancreas*, or, as it is popularly termed, *sweet-bread.*

The liver, as I before described, is a very large viscus which fills up a considerable portion of the abdomen, principally on its upper and right side—and the pancreas is a gland lying in its neighbourhood, close upon the spine.

The chyme being mixed with the secretions from these glands, passes slowly along, spreading itself over nearly the whole of the internal surface of the intestines; always, however, in the greatest abundance in the duodenum, and a few feet of the intestines beyond it.

LACTEALS.

Now there is in the human body a set of minute vessels called lacteals, which begin in great numbers, as if by roots, from the inner sides of the intestines, and gradually uniting as they proceed, at last all unite together into one principal trunk, or main pipe, which might be compared to the stem of a tree, with its branches.

These vessels seem to begin on the inside of the duodenum, and the other intestines, with open or funnel-shaped mouths, with which they suck up the finer or better parts of the chyme within them, and which, during the operation of being removed, is changed into a pearly-coloured or milky fluid, called *chyle;* and this process is called *absorption.*

The chyle, after being absorbed, is conveyed along

in the minute vessels it begins with: they, uniting with others, like small streams with larger ones, continually add to each other's size, until they all at length meet in a common trunk or receptacle, upon the first or upper vertebra of the loins. From this receptacle, one or more pipes, or ducts, carry the chyle which is contained in it upwards, on the right side of the spine, towards the top of the left shoulder, where, meeting the great vein which brings back the blood from the left arm, it empties its contents. The *chyle* thus mixes with the blood, which, immediately descending into the heart, passes through the lungs, to undergo a peculiar and important process, which will be afterwards explained.

Although performing so principal a part in the animal economy, yet the main duct, (and there is frequently but one,) called the *thoracic* duct, is in size extremely small; although loaded with all the nutritious materials for repairing and re-invigorating the entire body, yet it is only equal to the dimensions of a very small quill.

ABSORBENTS.

There is yet another series of vessels which are found in almost all parts of the human frame, both internal, among the viscera—and external, among the muscles and skin. These are very extensive, of minute size, and are situated in great numbers at the inner parts of the thighs and arms, at the neck, and in the groins. They are much the same, in arborescent

appearance like the blood-vessels, only very much smaller, indeed seldom visible to the naked eye, excepting when made prominent by disease. These vessels are called ABSORBENTS, the office of which is to absorb or suck up any particles not wanted in one place, and carry them back into the blood, to be sent round again by the circulation, to be used where they are really wanted; or else to be expelled from the body. The liquid which is thus found in these vessels is called *lymph;* it is of a pale red colour, but entirely different from blood. Besides having the general name of absorbents, these vessels are sometimes called lymphatics.

The chyle, in its pure state, is similar to the blood, excepting in colour. The little globules, which swim in the blood, and are the cause of its colour, are numerous in the chyle; but instead of being red, as in the blood, they are white. I have said that the chyle, in its nature, is like the blood; and concerning the nature of the latter, I shall have occasion to say more presently.

Whether the chyle is changed to a red colour as soon as it is mixed with the blood, or whether the change does not take place till it has passed with it through the lungs, we can better judge, perhaps, when we come to speak of the blood, and the changes it undergoes in those organs.

Having thus traced the food, or raw material, through the whole of a most wonderful manufacturing process, till chyle, and perhaps blood, is formed from it, it may be well to pause, and consider, for a few moments, the

different materials from which this most important fluid is prepared.

MATERIALS FOR BLOOD.

The great Creator has so formed this wonderful apparatus, that it has the power of forming chyle from almost every substance, either in the animal or vegetable kingdom. Some create more, others less: some make it of excellent quality; others of a very inferior nature; from some, it is formed very rapidly; from others, very slowly: some things, in the process of digestion, give out a great deal of heat; others, very little: lastly, some produce great excitement and disturbance of the stomach and other organs, while others produce hardly any disturbance at all.

As a general rule, those things which produce the least derangement of the digestive and the other organs of the body, as well as give out the least heat, make the best chyle and the best blood, and are, of course, most adapted to our use. It must be observed, however, that much depends upon habit; and that a substance which is naturally rather inferior to another may, by habit, be rendered for a time even more useful.

Among the best materials for subjecting to the process of digestion are, bread made of wheaten flour, from one to two days old; puddings made of rice, sago, tapioca, or flour; potatoes, and other garden vegetables, with the addition of plain meats, fish, eggs, butter, &c., and fruit. For infants, who have no teeth, milk, as is well known, forms the best

chyle, and creates the best blood. All these substances may be better or worse, according as they are well broken down and masticated with the teeth, and duly mixed with the saliva; and also according to their quantity. The best of them, if not well masticated, makes but an inferior sort of blood; and those which are the least nutritious, if duly subjected to the action of the teeth, make chyle, and blood which answers, in a great degree, the purposes of health. So of quantity: those which are even excellent in their nature, are not so advantageous if taken in too great abundance. Spirits make no chyle or blood at all; wine, cider, ale, beer, coffee, and tea, very little. Besides this, they contain, more or less, qualities which not only do no good, but are positively hurtful. Even water can hardly be said to make either chyle or blood; but then it quenches thirst, supplies the waste caused by evaporation, and answers many important and even indispensable purposes.

I am now to tell you about the blood;—first, what it is; secondly, its uses; thirdly, how it is kept in a good and healthy condition.

NATURE OF THE BLOOD.

If we open a vein with a lancet—as you know surgeons often do—and draw out a quantity of blood into a bowl, or any other vessel, and let it stand in the open air, it soon begins to clot, or thicken, or, as it is usually called, to *coagulate.*

From the surface of this coagulated part, a yellowish watery fluid oozes out, in numerous small drops, which gradually increase and unite, till, in a short time, there is more of this thin liquid than there is of the thicker coagulated part. This watery part is called the *serum*.

If we take the coagulated part of the blood, and wash it thoroughly, though carefully, we may divest it of nearly all its colouring matter, and leave it white. This white substance is called *fibrine*, and strongly resembles the fibrous or thread-like substance, of which I have already told you the muscles are formed.

The colouring matter, which is washed out, consists of small round or *globular* particles, which, before the blood coagulates, float in it; but in the act of coagulation become entangled in the fibrine. You have also been informed, in another place, that these globules exist and float in the same way in the chyle, before it mixes with the blood. In the chyle, however, they are colourless.

What gives the colour to these globules in the blood we are ignorant of: some suppose it is the iron, or rather phosphate of iron, which, as is well known, exists in the blood in a small quantity; of which Dr. Good thinks that there are about three ounces contained in an adult. Sulphur also is found in the blood; but its exact proportion is not known.

Thus we see that the three principal ingredients of the blood are the colouring matter, the fibrine, and the serum. The serum is principally albumen

and water; though it also contains, in small proportion, besides sulphur and iron, a great variety of substances, especially the alkaline salts. Albumen is a substance which may be considered as resembling the white of an egg: for the latter is almost entirely composed of it.

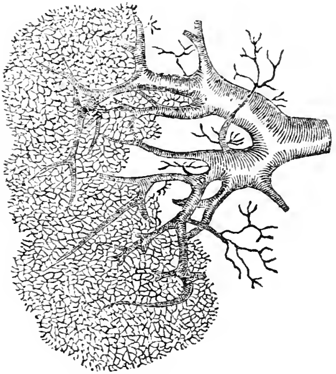
USES OF THE BLOOD.

All parts of the human body, whether solid or fluid, and whatever may be their appearance or structure, are formed from the blood. I have told you how this fluid is sent out by the heart to all parts of the system, even to the bones; and I have also said a few words about the saliva, and the gastric juice, and the bile, and have called them secretions.

It may be necessary to observe, in this place, that by the word *secretion*, as used in this sense, is meant something formed from the blood. Not only the saliva, the tears, the gastric juice, the pancreatic fluid, and the bile, are secretions, but the mucus which is everywhere found in the mucous membranes of the body, the water which is in the brain, the lungs, &c., in short, whatever fluid is met with in the body—in all parts of it, excepting the alimentary passages—is formed from that common reservoir, the blood; and all these fluids are called *secretions*.

You will perhaps ask how secretion is effected: sometimes it is by the intervention of *glands*, and sometimes without their aid. A gland is a soft body, full of vessels, arteries, veins, nerves and absorbents, and which are so numerous that the organ seems to

be entirely composed of them. Here is a representation of the vessels of the kidneys, as they would appear after the intermediate parts had been corroded away, which can be effected by means of an acid preparation.



The kidney, however, is not so good a specimen of the nature of a gland, as is the liver. The larger glands of the human body are, the liver, the spleen, the pancreas, the parotid, with the other salivary glands, &c. Besides these, there are small glands almost innumerable. The cerumen of the ear, and the oil of the skin, of which I have already spoken, are secreted by little glands.

The lymphatic or absorbent vessels are everywhere connected, in their passage through the body, with glands. Some of these are comparatively large, some

smaller, and most of them are very small indeed. Those little swellings called *kernels*, which sometimes appear in the sides of the neck, or in the armpit, are nothing but inflamed lymphatic glands.

All these glands (except the lymphatic glands, whose use is unknown,) secrete something; and the material from which all secretion takes place being the blood, it is sent to them from the heart, and distributed to their innumerable little vessels.

NATURE OF SECRETION.

I have already observed that some of the liquids, &c., of the human body seem to be secreted without the help of glands. They appear to be formed directly from the blood-vessels: how, we do not know. It has been conjectured that they ooze through the sides of the vessels, and some late experiments seem to corroborate this opinion. Here, perhaps, in one vessel, is blood; there, on the outside, and hardly a hair's breadth from it, is gastric juice, or some other entirely new substance. In one place is simple chyme or chyle, and closely contiguous to it is blood, arterial and venous. Here is chyme or chyle, made of ordinary alimentary substances, with neither sulphur, nor iron, nor nitrogen in its composition; there, perhaps, not the twelfth part of an inch distant from it, is a fluid made from the very same liquid—the blood—containing all these materials.

By what secret and incomprehensible laws of the

Creator have these little vessels this wonderful power? By what mysterious process can they change, in an infinitely short space of time, a bland, milky substance, made from simple bread, or milk, or vegetables, into iron, or sulphur? Of all this we know nothing, but so it is. Well, indeed, might David the Psalmist express wonder.

Not only the liquid, but the solid parts also, are made from the blood. The very bones themselves, at first gelatine, are gradually converted into bone, by a deposition from the blood contained in its little vessels. First a particle of gelatine is taken away by the absorbents; then comes along a particle of blood, or something that the blood contains, and remains in its place, and so on.

These particles, which are thus conveyed to form bone in the place of gelatine, are most of them lime, or phosphate of lime, or at least something which makes lime, before it can become bone. Who directs the little particles of lime to the places where they are wanted? Who tells them to stop at the bones, and not before? The same beneficent Creator who arranges all the other wonderful things contained in our bodies.

The power of the system to take out from the blood what is wanted for its growth and support, is aptly, though quaintly, shown by Dr. Edwards. Speaking of the wonderful distribution of the blood, in the little arteries, to every part of the body, he thus adds:

"Along, on the lines of these tubes or canals,

(the arteries,) through which the blood, with all its treasures, flows, God has provided a vast multitude of little organs or waiters, whose office is, each one, to take out of the blood, as it comes along, that kind and quantity of nourishment which it needs for its own support, and also for the support of that part of the body which is committed to its care. And, although exceedingly minute and delicate, they are endowed by their Creator with the wonderful power of doing this, and also of abstaining from, or of expelling and throwing back into the common mass, what is unsuitable, or what they do not want, to be carried to some other place, where it may be needed; or, if it is not needed anywhere, and is good for nothing, to be thrown out of the body as a nuisance.

"For instance, the organs placed at the ends of the fingers, when the blood comes there, take out of it what they need for their support, and also what is needed to make finger-nails; while they will cautiously abstain from, and repel, that which will only make hair, and let it go on to the head. And the organs on the head carefully take out that which they need for their support, and also that which will make hair, or, in common language, cause it to grow; while they will cautiously abstain from taking that which is good for nothing except to make eyeballs, and let it go to the eyes, and will even help it on. And the organs about the eyes will take that, and work it up into eyes, or cause them to grow. And so throughout the whole."

By this it is plainly seen that there must be a constant waste in every part of the system. It is impossible but that the friction—the "wear and tear" of hundreds of muscles and tendons, and thousands of rapid streams—should gradually produce decay, let the parts be ever so hard: a continual dropping will wear away a rock.

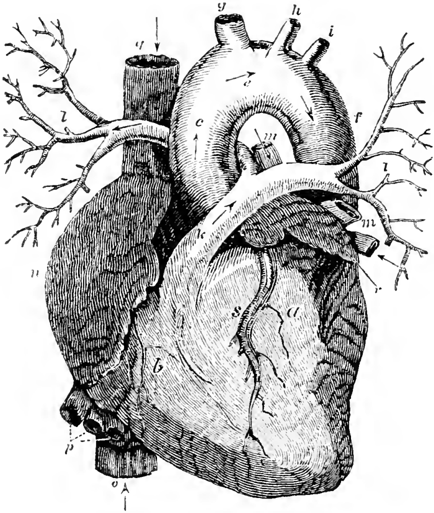
Now the blood not only carries out little atoms or particles to cause all parts of the body to grow, and to replace the atoms that were worn off by friction, but it also takes away the worn-out and good-for-nothing particles, and carries them clean out of the body. It is true that they are taken up by the absorbents in the first place; but then the absorbents carry them to the blood, and empty them into it, which amounts to the same thing. In this way, as you may easily see, the blood is liable to lose its purity and excellence, since it is constantly giving out good particles, and receiving bad ones.*

MOTION OF THE HEART.

The heart is kept in motion, we know not how; nor can the wisest anatomist or physiologist in the world tell us. We know that the lungs have something to

* The manner in which the bad or waste particles are removed from the system is very curious. Take the kidneys, for instance, which seem to be a sort of sieve or filter; with this difference, however, that while a sieve only permits the finest and best parts to pass through it, the kidneys filter out the worse or coarser parts. These are carried in two pipes, called *ureters*, to the bladder, whence they are conveyed immediately out of the system.

do in the case ; and when once set a-going, we can form some idea of what keeps it in action ; but, after all, the real cause of the continual motion of either the heart or the lungs is a great mystery, and will probably remain so for ever.



You are aware that the motion of the heart can be felt when a hand is placed on the left side, near the middle of the ribs. This important organ—not much larger than a man's fist, and strong and muscular—is situated slanting, or obliquely, as you see in the above

engraving. It is represented nearly in the position in which my heart would appear, if you could stand before me this moment, and see it just as it now is, in full motion. I mean, its position is just what it would then be. In other respects, it would appear differently, especially in its connexions; for the vessels which go to it and come from it are here represented as partially removed.

This engraving represents the heart with its principal vessels divested of their covering, called in technical language the *pericardium*, or, familiarly, the heart-purse, which closely envelops the entire heart, and the commencement of the great vessels connected with it. This is one of the strongest membranes of the body, and, like all other parts, is supplied with arteries, veins, and nerves. In the view now represented, this heart-purse is cut away, and the heart itself exposed to view. I mentioned a little about the heart in a former chapter, but, as I am now about to explain its functions, it will be necessary, for the elucidation of the subject, to go a little more into detail.

The heart, then, is a hollow muscle, and, in persons of the ordinary standard, is about a pound in weight, varying, however, in this respect; its shape is conical, and it is placed in the chest, under the cartilages of the ribs and the breast-bone. The base, which is much the broadest part, and whence the great apertures are placed, is turned obliquely upwards and backwards, almost facing the spine, while the point or narrow end projects forwards

and towards the left side. The heart contains within it *four* distinct chambers or cavities, two on the right side and two on the left; an *auricle* and a *ventricle* on each side, one of which, on the upper and right side of this viscus, is called, for the sake of distinction, *the right auricle,* and which receives the terminations of the two great veins of the body, *the venæ cavæ.* The next chamber is the *right ventricle,* a cavity much larger and thicker than the last, and lined with strong muscular projections. The orifice between these cavities is encircled by a tendinous ring, which gives attachment to a valve, and from the circumstance of its having three divisions in its substance, is called the *tricuspid valve,* and which is fixed to the strong muscular columns just mentioned by several thin tendinous cords.

From the upper and left side of the right ventricle emerges the *pulmonary artery,* which has also valves at its entrance, called *semilunar valves.* This artery is of considerable size, and passes behind the breastbone, dividing into two branches, corresponding to the right and left lobes of the lungs, and these again, ramifying in still smaller divisions, gradually become more minute throughout the entire substance of the lungs.

At the extreme ends of the smallest branches of the pulmonary artery commence, in a series of corresponding minuteness, *the pulmonary veins;* these, gradually uniting, form four great trunks, which find their termination in the *left auricle* of the heart.

The left auricle is in appearance and size very similar to its companion on the other side, excepting that it is much stronger in its texture. Adjoining to it, and towards the front of the body, is situated the *left ventricle,* separated from the last chamber by a valve, which, from its supposed resemblance to a bishop's mitre, is named the *mitral valve.* This ventricle is considerably thicker and stronger than its fellow on the right, though much the same in point of size: it is separated from the right ventricle by a very strong fleshy partition, which completely separates the two cavities, and allows of no communication between them. The same division also exists between the auricles, and, in like manner, they are totally distinct from each other.

From the upper part of the left ventricle is sent off the *aorta.* This great blood-vessel, where it begins, is in size about the same as the pulmonary artery, and has, like it, at its commencement, three semilunar valves; it passes upwards, making an arch of great capacity, and, travelling between the pulmonary artery and the great vein, the *vena cava,* before mentioned, turns downwards, pursuing its course along the spine, distributing large branches to various parts as it proceeds.

It is now time to call your attention to the plate, and to refer you to the figures which illustrate the different parts. The divided extremities of the two *venæ cavæ,* or veins which bring the blood to the heart from all parts, are shown; the upper and lower are marked *o* and *q*, with some other veins contiguous

to them at *p*. The right auricle is shown at *n*, and the left ventricle at *b*; *k* represents the pulmonary artery, of which *l l* are the right and left branches; *m m* exhibit the pulmonary veins, emptying into the left auricle; and *a* shows the left ventricle. The great arch of the aorta is shown by *c*, *e*, *f*; and the branches of this artery, which are distributed to the heart and upper extremities, are marked *g*, *h*, *i*. The direction in which the circulation proceeds is shown by the little arrows, following the course that an arrow would fly if shot from a bow; and the letter *s* describes the coronary arteries, or the vessels which feed and nourish the heart itself.

Now, the *circulation of the blood* proceeds in the following manner. The veins from all parts of the body unite to form the two *venæ cavæ*, which, entering into the *right auricle* of the heart, discharge their contents, contaminated by its traversing through the body, into that receptacle. By a muscular contraction of the part, the blood is pushed into the *right ventricle*, or second chamber, and is prevented from returning, partly by the tricuspid valves, and partly by the pressure of blood from behind. The right ventricle, being filled, contracts with great force, striking against the ribs, and producing the stroke of the heart, and discharges its contents into the *pulmonary artery*, which is again prevented from going back by the semilunar valves; by means of this vessel it is dispersed throughout the lungs. Here it meets the atmospheric air, which is continually being received into the lungs, and imbibing a

portion of the *oxygen,* or vital principle of the air, which is contained within it, becomes altered in colour and quality, losing the dark, venous hue which it had acquired while in circulation, and assumes a scarlet tinge, thus becoming true arterial blood, fit for the purposes of nutrition and secretion. Having thus received its vivifying principle from the atmosphere, it is conveyed by innumerable channels—the pulmonary veins—into the *left auricle,* by the sudden contraction of which it is propelled into the *left ventricle,* the *mitral valve,* aided by the continual pressure from behind, prohibiting a retrograde movement. From the ventricle —the fourth cavity of the heart—it rushes through the great arch of the aorta, from whence, by means of the arteries, it is distributed to every part of the body in a pure state; when, after performing all the duties demanded of it, in the various secretory processes to which it is subjected, it is returned by the veins in a contaminated condition, again to undergo the same passage through the heart, and to receive a similar revivification in the lungs. There is one thing more which demands notice among the phenomena of the circulatory apparatus, which is, that both sides of the heart fill at the same instant, the two auricles contracting at the same moment, and the two ventricles obeying the same law—thus, at the identical time that the right ventricle is pushing its blood into the pulmonary artery, the left ventricle is propelling its contents into the aorta, by which it will be seen that the auricles and ventricles contract and dilate alternately; the auricles and the arteries acting

together, and the same with the ventricles and the veins.

Valves, somewhat similar to those in the heart, are found in the larger veins all over the body; and now comes the reason why the blood can run up-hill. The pressure in the veins is all the while diminishing, as you may easily see, on the side towards the heart, even though it is the up-hill-side; and as the arteries, at their extremities, are all the while pouring their blood into them, the pressure must be as constantly and certainly increasing on the other side. Besides this *general* pressure, there is also *local* pressure. Veins lie, most of them, in the skin, or among the muscles, or among parts that are performing some sort of motion, and this motion must push the blood in one direction or another. But as the valves prevent its going back, the pressure is firm enough to make it go slowly up-hill; and thus it moves onwards and onwards, till it finds its way to the heart.

It is the contraction of the ventricles, which I have described, that causes the beat of the heart, and which is felt so plainly on the outside of our bodies. It takes place in an adult male, in good health, about once in a second; in females it is rather more frequent. It is greatest, both in males and females, at birth; and diminishes in frequency till we arrive at middle age.

PULSATION.

This beating of the heart, as the blood is pushed from it into the arteries, seems to be felt in the large arteries all over the body. I say *seems* to be; but the subject is not well understood. We only know that, if we lay our finger on an artery at the wrist, or in the ancle, or any other part of the body, where the vessels lie near the surface, we feel the *pulse,* as it is called; this beating in the extremities corresponding exactly with the beating of the heart.

It is from the frequency, force, tension, and other qualities of the pulse, that the medical practitioner is enabled to judge of the condition of the circulatory system, and for which purpose the beat at the wrist is generally preferred, and considered to be the same as all other parts of the body. In China, however, they think differently—there the physician is in the habit of feeling the pulse in various parts, being firmly impressed with the belief that it really varies in different places.

FORCE OF THE HEART.

The force with which the ventricles press the blood to push it out of the heart has been variously estimated. Some reckon it at only a few ounces; others at much more, and some even at 180,000 pounds. The truth is, it presses very hard, with a force apparently equal, if not superior, to that of the gripe of a very strong man with his fist. But it is more than doubtful if it exerts

a force equal to thousands of pounds, or even of hundreds. Perhaps it may average, in an adult, from twenty to thirty pounds.

One reason why anatomists have made such strange calculations is, that they could not conceive how the blood could otherwise be carried so swiftly through the system—and the distance it has to travel, in some instances, is very great, for the arteries are often extremely tortuous. But it seems to have been forgotten that, by the curious structure just mentioned, the veins are all the while getting empty, and a sort of vacuum* forms in the cavities, into which the blood naturally rushes from the arteries, so that the pressure, or rather the resistance of the latter, to the contents of the heart, is constantly diminishing, and thus there is a tendency to a regular current of the blood.

CAPILLARIES.

They appear to forget also the structure and functions of the little arteries—sometimes called *capillaries* —found in such great numbers in the skin, in the muscles, and, indeed, everywhere throughout the body. The truth is, that the coats of these little vessels, like other arteries, are muscular, and it is a pretty well established fact, that they have the power of drawing the blood from the heart. Some eminent professors of surgery have thought that these capillary vessels did almost all the work, the heart itself doing very little.

* It is said, and with some truth, that nature abhors a vacuum.

They have considered them something in the light of little pumps, in every part of the body, that were continually pumping up the blood from the deep well of the heart, to the extremities of the remotest chambers of the frame. You may form some idea of their meaning, by recalling to your recollection houses, in which water is carried up, by means of pumps and other machinery, to every room in the house, even to the highest story, and to the remotest chambers.

The truth here, as almost always happens, falls between the extremes. The heart really pushes the blood with considerable force; and the muscular capillaries, at the same time, act in some slight degree like little pumps. Then the vacuum I have spoken of has some influence; and there may be other causes in operation which I have not mentioned. The whole process of circulation is wonderful, and it requires a volume to illustrate and explain it fully.

POPULAR SUMMARY OF THE PROCESS OF THE CIRCULATION OF THE BLOOD.

I will here insert an eloquent description of the circulation of the blood, extracted from that useful and popular periodical the *Saturday Magazine*, a work which blends sound instruction with forcible lessons of piety. Though this will involve a repetition of some parts of the same subject, yet its importance is so great, that the time bestowed on the perusal will be amply repaid.

"The heart, which is the principal organ of circulation, is placed within the breast, between the two lobes of the lungs. It is a fleshy substance, and has two cavities, which are separated from each other by a valve. From the left ventricle, a large blood-vessel, called the *aorta*, proceeds, and soon divides into several branches, which ascend and descend by innumerable ramifications, become smaller as they proceed, and penetrate every part of the body. When the right ventricle contracts, the blood is propelled into the arteries with so much force, that it reaches the minutest extremities of their most remote ramifications. This motion is called the *pulse*, which is merely the effect of the pulsation of the heart, and is quicker or slower according to the frequency of its contractions.

"When the blood arrives at the extremities of the arteries distributed through the body, Nature employs it in the wisest manner. Certain vessels absorb the watery, oily, and saline parts. In some parts of the body, where the arteries are distributed, the secretion of milk, fat, and various fluids is performed: the remaining portion of blood flows into the extremities of the *veins*. These vessels gradually enlarge in size, till they form very large tubes, which return the blood back to the right ventricle of the heart. The blood is then propelled into the *pulmonary artery*, which disperses it through the lungs by innumerable small branches. It is there exposed to the action of the air, is afterwards received by the pulmonary veins, and by them is conveyed to the left *auricle* of the

heart. This contracts, and sends it into the left *ventricle*, which, also contracting, pushes it into the *aorta*, whence it circulates through every part of the body.

"For this complicated function, four cavities, as we have seen, become necessary, and four are accordingly provided: two called *ventricles*, which *send out* the blood (one into the lungs in the first instance, the other into the mass after it has returned from the lungs): two others, called *auricles*, which *receive* the blood from the veins (one as it comes immediately from the body, the other as the same blood comes a second time, after its circulation through the lungs, for without the lungs one of each would have been sufficient.)

"Such is the admirable circulation of the blood in man and most animals. But there is still much obscurity in this interesting subject. We meet with wonders here, that prove how incapable the human mind is of explaining this work of Divine wisdom. 'The wisdom of the Creator,' saith Hamburgher, 'is in nothing seen more gloriously than the heart;' and how well doth it execute its office! An anatomist, who understood the structure of the heart, might say beforehand, that it would play; but he would expect, I think, from the complexity of its mechanism, and the delicacy of many of its parts, that it would always be liable to derangement, or that it would soon work itself out. Yet shall this wonderful machine go night and day for eighty years together, at the rate of one hundred thousand strokes every twenty-four hours,

having at each stroke a great resistance to overcome; and shall continue this action for this length of time without disorder and without weariness!

"From KEILL's *Anatomy*, we learn that each ventricle will contain at least one ounce of blood. The heart contracts four thousand times in one hour, from which it follows that there pass through the heart every hour four thousand ounces, or three hundred and fifty pounds of blood. The whole mass of blood is said to be about twenty-five pounds, so that a quantity equal to the whole mass of blood passes through the heart fourteen times in one hour, which is about once in every four minutes.

"'Consider,' says PALEY, 'what an affair this is, when we come to very large animals. The *aorta* of a whale is larger in the bore than the main pipe of some waterworks, and the water roaring in its passage through a pipe of that description is inferior, in impetus and velocity, to the blood gushing from the whale's heart.' Dr. HUNTER, in his account of the dissection of a whale, says, 'The *aorta* measured a foot diameter. Ten or fifteen gallons of blood are thrown out of the heart at a stroke, with an immense velocity, through a tube of a foot diameter. The whole idea fills the mind with wonder.'

"The account here given will not convey to a reader ignorant of anatomy anything like an accurate notion of the form, action, or the use of the parts, or of the circulation of the blood (nor can any short and popular account do this): but it is abundantly sufficient to give him some idea of the wonderful mechanism bestowed

on his frame, for the continuance of life, by the hand of a Being who is all-wise, all-powerful, and all-good, and whose bountiful care is equally extended to the preservation and happiness of the humblest creature in existence, which has been, equally with ourselves, called into life at his Divine behest, and for a wise and good purpose."

Chapter XVI.

FURNITURE AND ITS USES.—Continued.

We are now prepared to enter upon another subject—the study of the process by which the purity of the blood is promoted, notwithstanding the many causes which are continually in operation to render it unfitted for its purpose.

PURIFICATION OF THE BLOOD.

This is effected by the aid of atmospheric air. But how is air to be introduced into the human body? Can we eat it? Can we drink it? Can it enter by means of the eyes, or the ears, or the nose? Not exactly in either of these ways. It can, indeed, enter through the nose, but, without some other machinery, it would go no further than the throat before it would return, or pass out at the mouth: a little, it is true, is swallowed, both in our food and in our drink; but the quantity in this way is very inconsiderable.

There is air, moreover, in almost every part of the body; all the great cavities—the chest, the abdomen, &c.—contain air; were it not thus, we should soon be crushed. The atmosphere in which we live presses upon the whole frame with a tremendous force, computed at about fifteen pounds' weight upon each square inch of the body; and its entire pressure on a middling-sized man is estimated at about thirty-two thousand

pounds. But as there is air within us, in almost every part, both solids and fluids, which forces outwardly, while the atmosphere keeps up a pressure in the opposite direction, we are not sensible of its weight.

But when I said that the blood must be purified through the agency of the air, I meant in a manner much more rapid and effectual than could be done by its gradual introduction and circulation through the vessels. The manner in which this great change is effected I will now explain.

THE LUNGS.

The House I live in contains a curious apparatus, which may be compared to a great bellows, by whose wonderful operation the blood is cleansed and purified. This is contained in the upper story, and fills nearly the whole of it, leaving but a small chamber on one side for the heart. It blows its blasts at the rate of twenty or twenty-five in a minute in an adult person, and at a still greater rate in children; and it continues these blasts, whether standing or sitting, sleeping or waking, as long as we live. I refer, as you will readily perceive, to the lungs. I have already spoken briefly concerning these organs. I have told you about the windpipe, which leads by its various branches to the myriads of little cells within them; and I have told you that all those cells were lined throughout by mucous membrane, a membrane constructed in all its essential properties like the skin, but much thinner. But I believe I have not yet told you

how much air these minute cells, which fill up the whole substance of the lungs, will contain, nor how great is the superficial extent of the membrane over which the air is spread for the purpose of purification.

So numerous are the pipes and cells in the lungs, that it is commonly considered that the extent of the mucous membrane which lines them must be equal, at least, to the extent of the skin, which is, in a middling-sized adult, about fifteen square feet. Over all this surface, the fresh air which we breathe, while we are in health, circulates, fulfilling its office in effecting that change in the blood of which I am presently to speak.

CAPACITY OF THE LUNGS.

As to the quantity of air which the lungs will contain, it is very differently estimated. Many physiologists think it to be about two hundred cubic inches, or three quarts, in the adult male; but more recent experiments have led to the belief that two quarts is nearer the average quantity. When we breathe out, or *expire*, as it is called, all the air which is actually in the lungs is not expelled, but only a small part of it. Of course, when we draw in, or *inspire*, we merely introduce air in quantity sufficient to supply the place of that which is discharged. The process of inhaling the air is called *inspiration*—that of expelling it, *expiration*, and the whole process of breathing is called *respiration*.

The amount which we draw in or inspire at each

breath (still speaking of an adult) is thought to be about forty cubic inches, or something more than a pint; but this estimate has also been considered as too high. Females, whose lungs are generally somewhat smaller than those of males, inspire a quantity still less, and children consume a much smaller portion of air than either.

BREATHING.

But how is the process of breathing performed? To understand this, it is necessary to revert once more to the structure of the frame-work of the human system.

The ribs, though fastened to the spine, or back-bone, are not so firmly fixed but that they admit of considerable motion, and this motion is very curious, though somewhat difficult to describe in a work of this kind. I can only say that it is of such a nature, if unconfined by external pressure, or unrestrained by disease, as materially enlarges the cavity of the chest when inspiration is performed, and in expiration diminishes it to a corresponding extent.

This motion of the ribs is partly caused by the shortening or contraction of the muscles about the chest; of these, there are two between every two ribs; and as there are on each side twelve ribs, making twenty-four in the whole, there are forty-eight of these muscles concerned in moving the "bellows" every time I breathe. In addition to these, there are nearly one hundred other muscles that are more or less concerned in this operation.

In a healthy adult, from twenty to twenty-five of these inspirations are usually performed in a minute, as I have before observed. When violent exercise is taken, as in running, leaping, or swimming, the motion is more rapid. So, also, in childhood, and frequently in fevers and other ailments. When the lungs are put into unusual operation, by great exertion of the body, the motion of the heart is accelerated in the same degree; the breathing and the contractions of the heart bearing an exact proportion to each other.

Now what is the object of all this motion? For what purpose is a pint of air drawn into the lungs, and spread over fifteen square feet of internal surface, every three seconds, and another pint exhaled from them as often? To what advantage is all this unceasing machinery directed? This I can in part explain to you.

USES OF BREATHING.

In its healthy and natural condition, before it is distributed throughout the body, the blood is composed of four materials, called by chemists *simple elementary* substances. They are called elementary substances because they do not suffer decomposition, or, in other words, are not capable of being divided into several parts or proportions. Formerly, there were more substances comprehended under this title than are now considered as such. By the powerful aid of galvanism, many bodies are decomposed which were once thought to be simple or elementary,

and the number is being still further reduced. We need here only mention four of them—viz., oxygen, nitrogen, hydrogen, and carbon. The blood, then, is composed of the four materials just mentioned, in these proportions—in a hundred parts of blood, there are fifty-three parts of carbon, twenty-four of oxygen, sixteen of nitrogen, and seven of hydrogen.

But when it has been circulated throughout the body, and has been returned through the veins to the right auricle and ventricle of the heart, its properties become greatly changed. It is now of a deep purple hue, and has hence often been called black blood. In this state, it is found to be loaded with too great a proportion of carbon; and this, too, notwithstanding what has been done in the way of clearance by the skin; for it is a most striking fact that this very work of purifying the blood, of which I am about to speak as taking place in the lungs, takes place in a small degree all over the whole surface of the body. Still, it does not complete the work, and the blood yet comes from the heart, through the pulmonary artery, to the lungs, in its impure black or purple state, not only overloaded with carbon, but mixed with other noxious ingredients, which it has acquired in its passage through the body, and which additions render it unfit for the use of the organs to which it is again destined, in forming their various tissues, secretions, &c., until it has received purification. It also brings back with it, at least a few hours after every meal, a mass of chyle, with which it has been lately mixed, and which probably needs a change

to be effected in the lungs before it is enabled to become blood, and to afford proper nourishment to the system.

Arrived in the lungs, it is spread almost immediately over the vast space which is afforded by their numerous cells, and is thus exposed to the influence of the atmospheric air. A most surprising change is thus produced; the blood is now sent back into the *left auricle* and *left ventricle* of the heart in a purified and renovated state. Its colour is changed to a bright scarlet; it has lost its superabundance of carbon, and other deleterious qualities, and has acquired new life and renewed vigour.

Concerning the precise nature of this change—whether the blood takes in something from the air, or whether the air takes something from the blood,—there has hitherto been a great difference of opinion, and even now the point is not completely decided. It is sufficient for us, in a book like this, to know that a change does take place, and what the results of that change are in regard to health.

NATURE OF THE AIR.

But I must not pass over this part of my subject without mentioning the changes which take place in the air during its detention in the lungs, coming, as it does, in such close contact with the blood. This air, in its natural state, and when in a proper condition for respiration, consists of about eighty parts of nitrogen gas, and about twenty parts of oxygen

gas. Oxygen gas is frequently called *vital* air, on account of its property of supporting life; and, indeed, without a due admixture of this gas, neither the animal nor the vegetable kingdom could continue its existence. On the other hand, pure oxygen, or even if mixed in too large a proportion with the other compounds, would be quickly destructive of life, by causing a rapid consumption of the energy of the body.

In addition to the oxygen and nitrogen gases, the air is generally considered to have a proportion of carbonic acid gas mixed with it, even in its purest and healthiest state. But no sooner has it passed through the lungs—even once—than the oxygen is greatly diminished in quantity, apparently being *absorbed* by the blood, while the carbonic acid has much increased in abundance by what it has *acquired* from the same source. If we continue to breathe the same air twice, thrice, or more, the carbonic acid becomes still more abundant, while the oxygen as rapidly decreases, till it is at last perfectly irrespirable.

BREATHING AIR TWICE.

Now if we breathe air twice over, or if we breathe that which has a superabundance of carbonic acid in it, derived from any other source, it does not sufficiently change the blood from its black to its scarlet colour. It is consequently sent back to the heart, and distributed all over the body in a state totally unfit for the purposes for which the great Creator designed and gave it; and if this abuse is long permitted, the health

materially suffers. Instances have been too frequently before us, in the crowded state of prisons, infirmaries, workhouses, &c., and one particularly in the too celebrated Black Hole at Calcutta, to need our saying much more in this place.

The air is changed by inspiration at a most astonishing rate. We inhale, probably — speaking now of adults, for children inhale proportionably less—more than a gallon in a minute, or about forty hogsheads full in twenty-four hours.

Air which has been once breathed may be considered as unfit for further respiration, and as totally spoiled for the purposes of animal life. Admitting this to be the case, we spoil the air for the purposes of breathing at the rate of more than a gallon a minute. Dr. Franklin, half a century ago, advanced this opinion, which has been since amply verified by succeeding philosophers.

VENTILATION.

Now, if these statements are correct, and that they are so admits of no doubt, how careful ought we to be that the rooms in which we sit, and particularly those in which we sleep, are not too tightly closed, or too long shut in! What pains ought to be taken to promote *ventilation*, by frequently opening the doors or the windows; and this is the more necessary where there are no fires, for a fire assists in ventilating a room, by causing a draught of air from all directions towards the chimney. In rooms where there is no chimney, a fire is very prejudicial, since it deprives the

atmosphere of its oxygen, and rapidly increases the carbonic and other poisonous gases which are given out during the process of combustion. The newspapers have at various times teemed with accounts of persons having been found dead in rooms where charcoal had been burning, and from which fresh air was excluded.

School-rooms, concert-rooms, theatres, churches, how dangerous must it be to crowd and continue in them for so long a time as we sometimes do, without ventilation! How easy is it to raise a window, or to open a door! And though we might thus expose an individual here and there to cold, yet how much more injurious on the whole, must it be to sit in close apartments, and continually to breathe a contaminated atmosphere!

FREE MOTION OF THE LUNGS.

Not only should the air be good in quality, but the lungs should have free play in inhaling it. From youth to maturity, no employment should be followed which for any considerable time will cramp or confine their operation. Neither should we sit or stand for a great length of time in a bad position, as young people in schools or factories are too apt to do. Nor should our dress be so tight as to press closely against any part of the chest.

How much is it to be regretted that there are parents and instructors, and even teachers in military schools, who think it necessary to injure the functions of the lungs, and thus induce disease, and excite a ten-

dency to shorten life, in order to teach their children, pupils, or cadets, the art of putting back their shoulders and walking erect!

TIGHT LACING.

Health is always injured by every kind of lacing, as well as by stays, braces, corsets, tight vests, &c. Not only is the body the more exposed to colds, pleurisies, fevers, and consumptions, but also to diseases and malformations of the very bones themselves — the breast-bone, the ribs, and the spine. I say again, therefore, beware of anything tight about the chest. The Prussian physicians recommend people to wear no cravat or stock, and to leave their bosoms unbuttoned and bare; and no people in the same climate, and under the same circumstances in other respects, are more free from consumptions and all sorts of diseases of the lungs, than are those who observe this rule, though it may be doubted if in so humid a climate as Great Britain, the practice of exposing the chest could be long adopted with impunity.

It is very strange that so many people—and some, too, who consider themselves very wise—should still entertain the idea that lacing the chest in a moderate degree improves the action of the lungs, and gives strength to the muscles of the part. A popular writer of *Lectures to Young Ladies*, inculcates this erroneous idea; and too many others who have been held up as monitors of youth, have been under the influence of the same delusion.

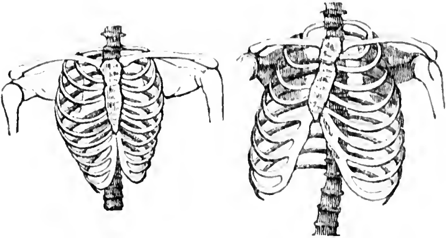
The fair sex, in most European countries, have been singularly in error in this respect; under the false impression of improving the figure, they have taken pains to distort it. Few of our fashionable belles, with all their intended aids and appliances, can rival in the beauties of form, and the harmonies of symmetrical proportion, the females of Turkey, of Georgia, of Otaheite, and other countries where nature is left to her own unrestrained luxuriance.

We generally succeed far better in our attempts to mend or alter the works of human ingenuity, than in those of the great Creator. He appears to have made the human frame so perfect, with such complete unity of design, and such adaptation of means to an end, that it is wonderful that in our ignorance we should continue such vain attempts to improve it. Were we not continually endeavouring, by various mistaken means, to interfere with the due and just performances of the animal machine, it might continue in healthy operation for a much longer period than it now does.

In closing this chapter, I will show you a picture of the bones of two human chests, which have been accurately copied from nature; one is in a perfect state of health and elegance of shape, the other has been injured in form by tight lacing. You will observe that the one which has been distorted by the pressure of stays, has much less capacity for the free expansion of the lungs, and with consequently diminished means for the due oxidation of the blood.

I may also remark that this picture by no means exaggerates the evil effects of tight lacing. "This

deformity," says a learned physician, upon whose authority the engravings are given, "is not nearly so great as what we believe often takes place in many instances of tight lacing."



If what I have said on the nature and structure of the chest should lead any person to study the functions performed by its contained important organs, the lungs—if he should be induced by means of this little work to apply his reasoning faculties to the elucidation of the laws by which the vital processes of nature are carried into effect—I shall have reason to rejoice that my labour has not been misdirected, and I am sure that he will look back with satisfaction to that day on which his attention was first arrested, and the powers of his mind directed to the subject.

Chapter XVII.

TEMPERATURE OF APARTMENTS.

Few, if any, ordinary buildings, whether churches, houses, shops, or factories, are so constructed as to preserve exactly the same temperature in every apartment at all seasons of the year. As for *heating* themselves, and preserving one uniform temperature by means of the very employments or manufactures which are being carried on within them, probably no one ever heard or thought of such a thing. A self-heating house! Why, it would excite as much astonishment, as would a machine that was really endowed with the power of perpetual motion.

And yet the House I live in has this power, wonderful as it is, not only of heating itself, by the process of generating and purifying the blood, concerning which I have before treated, and by other very curious processes, but also of regulating that heat, and keeping it at the same point, with scarcely any perceptible variation.

The heat of the human body is never far from ninety-eight degrees of Fahrenheit's thermometer. By this is meant, that if the bulb of the thermometer, which contains the quicksilver or mercury, could be plunged into the flesh of the body, or even if it were to be held in the mouth, the mercury would rise in the tube till it arrived at the mark which indicates 98° or thereabouts, and there would remain.

Now why does this heat continue nearly the same at all times and in all places? If you were to take a piece of wood, or iron, about the size and shape of a man, and heat it to 98°, and set it up in Greenland or Lapland, where it is so cold that the mercury would sink to 20° in the open air, do you think this iron would remain heated to 98°? Would not the air cool it down to about 20°? How would it be with a man of wood or straw? How would it be even with the body of a *dead* man?

Does any one suppose that the body of a *dead* man, heated to the same temperature as that of a living being, would remain warm very long? Then why should the *living* body of a man? Why does not the cold air rob it of its spare heat, just as it would a mass of straw or iron? Yet the daily experience of our lives proves that it does not.

The skin and the outside of the hands, the face, and other parts of the body, may be very cold, and sometimes even actually *frozen*, but the blood and the flesh will generally remain at about the same temperature, unless the individual be absolutely *frozen to death*. In that case, the heat very rapidly escapes; the dead, as you know, very quickly becoming cold.

CURIOUS QUESTION.

But why the heat does not escape from everybody under ordinary circumstances, so that they become frozen to death, is the point in question. You will hardly suppose that there is a fire in the inside of

us which keeps up the heat: for, if so, what supplies the fuel? *Spirits* will burn, it is true, and when applied to many chemical and other purposes, afford the means of giving heat. Yet in the human body this is not the case, except perhaps for a very limited period. Although many persons adopt the pernicious habit of frequently drinking intoxicating liquors, yet their blood is in reality no warmer than is the blood of those who refrain from this practice; nay, it is even asserted by some experimenters, that the blood of the dram-drinker is actually a little colder than the blood of him who drinks little else but pure water.

When we think of all this, and remember that individuals can live very comfortably in climates like Labrador, and Greenland, Norway, Lapland, and Siberia, where everything around them—air, water, earth, trees—is cooled down to less than half the heat of the human body, for the greater part of the year, and as low as the freezing-point (32° of the thermometer) a considerable portion of the time, is it not a wonder that all our bones and flesh and blood can retain a temperature of 98°, not only through an hour, a day, or a year, but throughout the whole of perhaps a very long life?

It is indeed almost a miracle, or would be thought so if we concerned ourselves at all about it. It shows, at least, how wonderful *life* is. For not only *man*, but all *living* animals have this same power. Birds have even a higher degree of heat than man. The blood of some birds reaches a temperature of about

108°. If it were not so, they would soon become frozen to death in the cold season, and their bodies would probably become separated and fall to pieces, in like manner as the frost in swelling sometimes cracks the frozen ground, or as trees are sometimes split into fragments in very severe winters.

You should be told, also, that living trees and shrubs, and plants, and seeds, have this same power of resisting cold, though *in a less degree* than is possessed by animals. Trees do not often freeze very hard; and were it not for this contrivance of the great Creator, everything would perish in the winter, and we should have no beautiful foliage and verdant meadows in the spring. Seeds and roots would perish in the ground, and the regular return of the seasons would not produce those beneficent results which gladden our hearts and supply our wants.

But we not only have this wonderful power of resisting cold; we are also equally able to resist extreme heat. By long practice, men have been enabled to remain in ovens, and other places, heated to 220°, and even to 260° of Fahrenheit, for ten or twelve minutes at a time. The only serious inconvenience which arises in such cases is an extremely profuse perspiration.* But a piece of flesh without

* Perspiration always modifies the heat of the human body, more or less, and is one means of keeping us cool. The reason is, that the moisture on the surface of our bodies evaporates; and this produces cold. It is said that you may almost freeze a man in midsummer, by keeping him wet with ether; so rapidly does the ether evaporate.

life, if subject to so great a heat for only a few minutes, would be thoroughly baked, and the organization of the part irreparably destroyed. This heat is much greater than that of boiling water, which, as you know, is 212°, measured by the same thermometer.

Having laid down and illustrated the general rule, that the temperature of our bodies does not admit of much variation, it may be as well to mention some of those slight varieties which under different circumstances are found to exist.

VARIATIONS OF TEMPERATURE.

Infants, excepting when newly born, have a temperature only of about 94°. The heat increases as the body advances towards maturity, after which it remains nearly stationary at about 98°, until it begins to decline, when a slight diminution takes place. In the spring, and in the beginning of summer, it increases a little in people of every age; but it again declines towards winter; and when a person is greatly enfeebled by sickness, or otherwise, the temperature is slightly diminished. In fevers and in inflammatory diseases, it sometimes increases to 104° and even to 107°.

But I have not yet told you *how* this steady temperature of 98° is kept up in the human system, notwithstanding the extremes of heat and cold to which it is exposed. Indeed I cannot do it; for I do not know the cause. It is in some way connected with

the principle which we call *life*, but about the nature of which we are at present entirely ignorant. I have already told you that the evaporation of the matter of perspiration from the skin has some effect in keeping the body cool; but this cannot be the sole cause why men can remain with impunity in places heated to a greater temperature than boiling heat. There are doubtless other and more important causes, but the limited sphere of human understanding has not at present enabled us to discover them. As to the reason why we retain so high a temperature as 98°, when the atmosphere is at a considerably less degree of heat, we know nothing. There have been a great many speculations started by ingenious philosophers in various ages and countries, but they have been in general mere *guesses;* in many instances hardly amounting to plausibility. The process of digestion, the formation of chyle, the change of chyle into blood, and the alteration made in the blood during its passage through the lungs—but more particularly the latter—are all believed to have a part in the work. Yet it is considered that by all their united efforts they do not accomplish one-half of it; and it remains for future anatomists and physiologists to investigate the subject more deeply, and to endeavour to throw additional light upon the obscurity in which it is at present involved. Of late it is considered that electrical agency has much to do in the matter.

How far the laws by which the great Creator governs this universe, and keeps all its parts in harmonious action with each other, may ultimately be

discovered, we cannot say. In this, as well as in a thousand other things which are in daily operation, and on every side surround us, our ignorance is made manifest. Whether the extent of human knowledge will ever enable us to penetrate fully into these mysteries of creative wisdom is a problem yet to be solved. At present we can add but little to the exclamation of the Psalmist,—*We are fearfully and wonderfully made!*

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